

Yoga For Musculoskeletal Disorders: A Review of Prospective Clinical Studies

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Abstract

Objective: Musculoskeletal disorders (MSDs) include different pathological conditions of the locomotor system, characterized by pain and limitations in mobility and functioning. The most frequent arthropathies include joint disorders and arthritis. Yoga is an ancient mind-body discipline which has received great attention in clinical research. This critical review intends to analyze the updated literature on clinical outcomes of yoga interventions for MSDs.

Methods: Prospective clinical studies evaluating the effects of yoga for MSDs have been searched in Web of Sciences, Scopus and PubMed databases using yoga-related keywords in association with numerous disorders affecting the musculoskeletal system. We explored all protocols to identify similar movements or asana reported with different (uncommon) names or imprecise description, and to be useful for clinicians, we summarized yoga exercises with specific target for body areas and related pathologies.

Results: Overall, 1150 articles were screened, among which 52 prospective clinical studies (total 4151 patients) were selected. The clinical outcomes of yoga were compared with active control groups (rehabilitation, drugs) or passive controls (self-care education or no intervention). The analysis was performed towards specific musculoskeletal disease, affected body area, study type, yoga protocol details, and outcomes in measured and self-reported parameters. All 52 studies showed marked benefits in every or some parameters: measurable outcomes as well as self-reported improvements were higher in yoga groups than in controls, and in some studies even better than drug therapy.

Conclusions: This review highlights the potential benefits of yoga interventions for MSDs. Data highlights that yoga may help improve mobility, reduce reliance on medications, and enhance quality of life and could be considered as a complementary approach alongside conventional medical treatments. However, the heterogeneity of protocols, outcomes, and potential risks of bias highlight the need for rigorous trials to strengthen confidence in these findings and to identify the most effective protocols.

Keywords

yoga, asana, prospective clinical studies, musculoskeletal disorders (MSDs), low back pain, neck pain, tension headache, hip pain, shoulders pain, arthritis

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Introduction

Important world-leading journals of clinical, public health, and global health knowledge, such as *Lancet* and *BMJ* - highlight the pressing issue of population aging¹ and the increasing global burden of musculoskeletal disorders (MSDs).²⁻⁴ Recently, the United Nations, European Agency and WHO⁵ highlighted this alarming problem. MSDs represent a multifactorial growing worldwide problem and constitute the major cause of disability and limitation of daily working and social life,⁶ affecting approximately 1.7 billion individuals worldwide living with pain and limitations in mobility.²

MSDs include a wide over 150 conditions affecting the locomotor and connective tissue systems. These disorders can be broadly categorized into non-inflammatory and inflammatory types. Non-inflammatory MSDs include chronic back pain (such as low back disorders and neck pain), mechanical joint disorders, scoliosis, osteoporosis, and degenerative conditions like osteoarthritis. Inflammatory MSDs involve autoimmune or systemic processes and include rheumatoid arthritis, gout, psoriatic arthritis, ankylosing spondylitis, juvenile idiopathic arthritis, polymyalgia rheumatica, and lupus.²

MSDs showed an alarming 123.4% increase of total cases in the last 30 years (1990-2020)³ due to the rise in sedentary lifestyle and to the demanding strict working conditions aggravated by the aging of the population.²

In 2020, 494 million of new MSDs cases have been reported and 83 100 of these have been associated with death.

MSDs currently affect around 2 billion people/individuals worldwide² and a further 115% increase is expected from 2020 to 2050 to an estimated 1.06 billion new cases in 2050; most regions were projected to have at least a 50% increase in cases between 2020 and 2050.³

People suffering from joint and musculoskeletal pain and discomfort demonstrate decreased motion and strength, and kinesiophobia, showing a relationship between pain and (causal or consequent) limited/restricted range of motion.^{7,8} According recent studies and meta analyses, MSDs prevalence is 61% for low back and back pain and spine pathologies, 40.1% for hip soreness/suffering, 7.0% for shoulder pain, and 20.8% for osteoarthritis affliction.⁹

The age-standardized global prevalence of MSDs increases with age to a peak at 65-69 years in both females and males and is 47.4% higher in females than in males.

Older people are at increased risk of MSDs.^{1,10} The proportion of elderly people, that is, persons aged 60 years or older, increased from 8.0% in 1950 to 12.7% in 2017, and is projected to reach 21.3% in 2050.

In this context of expected aging, it becomes a priority to pay attention to MSDs and related disabling conditions with the focus on developing effective policies for their management and prevention. WHO in 2017 launched the “*Rehabilitation 2030 Initiative*” to draw attention to the

worldwide need to enhance prevention and rehabilitation in health systems, and the rehabilitation related to MSDs was among the most pressing needs.⁶

In May 2025, the World Health Assembly (WHA) adopted its third global strategy on traditional medicine which will run from 2025 to 2034, envisaging “people-centred TCIM [traditional, complementary and integrative medicine]” following Ministry of Ayush (AYUSH, i.e., Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homoeopathy) to integrate traditional Indian practices, such as Yoga, into WHO international health intervention classification system.¹¹

In the last decades, yoga received increasing attention and generated growing relevant medical research demonstrating its clinical effectiveness in many medical domains, in reducing symptoms and associated disabilities in ageing-related or unrelated diseases.¹²⁻¹⁴ Pioneering Western clinical studies have been published in top-rank medical journals since the 1960s¹⁵⁻²³ and emphasized the need to prescribe yoga and meditation to patients for well-being, healthy ageing^{12,17,24} and healthcare.²⁵

Yoga is an ancient traditional school of philosophy and practice assumed to have originated in northern India at least 2000 years ago. Historical evidence of the existence of yoga was seen in the pre-Vedic period (2700 B.C.), and thereafter till Patanjali period. Yoga is a mind-body practice involving deep concentration (*dharana*) with inward focusing (*pratyahara*, bringing the attention inwards), controlled/volitional breathing (*pranayama*), postures and mindful movements encompassing stretching and strengthening poses (*asana*), and meditation (*dhyana*) (Patanjali. *Yoga Sutras*, 200 BCE-200 CE; Krishnamacharya T. *Yoga Makaranda*, 1934; Iyengar BKS. *Light on Yoga*. New York: Shocken Books, 1979; Pattabhi K Jois. *Yoga Mala*. New York: North Point Press, 2002; White DG *Yoga, Brief History of an idea*. Princeton, 2011; Mallinson J, Singleton M. *Roots of Yoga*. Book Review, 2017; Eliade M. *Yoga: Immortality and Freedom*. Book: Princeton University Press, 1954).

Yoga protocols showed significant effectiveness for cardiovascular risk factors and pathologies,²⁶ gastrointestinal diseases,²⁷ pulmonary function such as hypoxia, hypercapnia^{18,19} and asthma,^{16,18} spine disorders²⁸⁻³¹ carpal tunnel syndrome,²⁰ chronic low back pain,²¹⁻²³ knee osteoarthritis,³² balance and mobility in older adults,³³ physical function,⁷ mental well-being and quality of life,^{34,35} cognition,³⁶ and for frailty and disability in older people.³⁷ Significant clinical evidence has also been demonstrated for psychological health,²⁴ side-effect management of cancer therapies,¹⁴ depression,³⁴ anxiety,^{32,36} and perceived stress.^{32,36}

This critical review intends to analyze and summarize the clinical evidence of yoga interventions for various MSDs to consider the possibility to use yoga as a complementary therapy and in some cases even as an alternative therapy in medical care. The ultimate purpose of this study is to outline the effects of yoga interventions for clinicians, academics and

researchers, in particular physiatrists, orthopedics, neurologists, geriatrists, rheumatologists, sports medicine specialists, and physiotherapists.

Materials and Methods

Search Strategy

A comprehensive manual search was carried out in electronic databases (Web of Sciences, Scopus and PubMed) by a combination of relevant keywords and MeSH (Medical Subject Headings) terms. Two authors independently read and selected the articles from May January 2023 to November 2024. Any difference in search results were resolved through discussion or consultation with a third reviewer.

Articles search has been performed for the different body areas and related disorders using the following keywords: “Yoga”, “Yoga techniques”, “Yoga therapy”, “Yogasana”, “Asana”, “Pranayama” and “Yogic breathing” in association with:

1. (for neck and head): Neck Pain, Neck Disorders, Tension headache;
2. (for shoulder, upper back, hand, wrist): Thoracic outlet syndrome, Frozen shoulder, Disk herniation and bulging, Upper crossed syndrome, Shoulder pain, Subacromial impingement, Supraspinatus syndrome, Entrapment syndrome, Carpal tunnel, De Quervain syndrome, Tendinosis, Tenosynovitis;
3. (for low back, hip, leg): Low Back Pain, Lumbar disc herniation, Spinal disk pathologies, Ischiofemoral Impingement, Femoroacetabular impingement, Piriformis syndrome, Hip impingement, Hip osteoarthritis, Hip pain, Hip extension and gait function, Patellofemoral Pain Syndrome, Knee disorders;
4. (for arthritis): Osteoarthritis, Inflammatory Arthritis, Nontraumatic Arthritis, Chronic Hand Osteoarthritis, Hip arthritis and Knee arthritis.

The search strategy is reported in [Table S1](#) supplementary material.

Eligibility of Retrieved Studies

Inclusion Criteria. Population: subjects with MSDs; Intervention: Yoga therapy; Study type: clinical prospective; Primary Outcomes: studies analyzing self-reported outcomes (such as pain, quality of life or disability) and/or measured parameters (e.g., articulation movement, strength, disability score, muscle electromyography, muscle thickness, inflammatory markers and immunological parameters, drugs assumption); Language: Full articles in English.

Exclusion Criteria. Studies were excluded if they were reviews, case reports, case series, or retrospective studies due to the

lack the methodological rigor and generalization. Articles without clinical data, incomplete results, or available only as abstracts were also excluded due to insufficient information for critical analysis and data extraction. Additionally, studies published in journals not indexed in recognized scientific databases were excluded to ensure the quality of the included literature.

Data Analysis

For each included clinical study, the following parameters were analyzed and summarized in detailed tables: Disease; Study type (RCT, Prospective, Pilot); Number of patients, age range and mean age; Yoga session duration and frequency; Study duration; Presence and type of a control group (active or passive); Main findings (objective or subjective outcomes); Benefits: yes (Y, statistically different improvements in yoga group compared to control group) or not (N, control group showed significant improvement compared to yoga group) or partial (some parameters significantly improved in Yoga group compared to control group) or similar (similar improvements in both yoga and control group) to the control; Yoga style; Yoga intervention that is movements (asana), breathing exercises (pranayama), relaxation techniques; Qualifications of yoga instructors. Yoga protocols have been reported in the tables without any change in sequences and (Sanskrit or English) asana names, despite sometimes written in an unusual way. Adverse reactions to yoga protocols were also accounted and divided in accordance to each paper definition as minor events (i.e., muscle pain, dizziness or nausea) or adverse events (i.e., herniated disk, muscle trauma or injury) or not reported (when no explicitly stated in the text).

Methodological Quality Assessment of Studies

Randomized clinical trials were assessed using the Cochrane Risk of Bias (ROB), evaluating 5 domains: D1: Random sequence generation (selection bias); D2: Allocation concealment (selection bias); D3: Blinding of participants and personnel (performance bias); D4: Blinding of outcome assessment (detection bias); D5: Incomplete outcome data and selective reporting (attrition/reporting bias). Each domain was judged as either low risk (“+”), high risk (“−”), or some concern (“!”), based on the level of methodological detail provided in each study.

Prospective studies were assessed using the Newcastle-Ottawa Quality Assessment Scale (NOS). The NOS assesses 3 main domains: Selection of study participants (maximum 4 points), Comparability of study groups (maximum 2 points), Outcome assessment (maximum 3 points). Each domain includes specific criteria, and a star (*) is placed for each criterion met. A maximum of 9 stars can be awarded in total. Based on their total NOS scores, studies were

categorized as follows: High quality: 7-9 points, Moderate quality: 4-6 points, Low quality: 0-3 points.

Results

A total of 1506 articles were found. After duplicate removal ($n = 356$), a total of 1150 full articles were screened. Papers not in the English language ($n = 86$), reviews ($n = 150$), articles with incomplete results ($n = 96$), abstract available only ($n = 46$), and papers not indexed in scientific databases ($n = 158$) were excluded. An additional 562 articles were removed as not analyzing yoga interventions ($n = 450$) or being case reports or case series ($n = 112$). A representative flowchart of search analysis is reported in Figure 1.

Overall, 52 prospective clinical studies (46 randomized and 6 prospective non-randomized) were included (total 4151 patients).^{21,22,24,38-83}

A critical analysis of the similarities and differences in postures and yoga techniques used in different studies and protocols for similar MSDs in analogous body areas

is presented in the discussion section and summarized in Table S2 supplementary material.

Head MSDs

Six randomized clinical studies on head MSDs (423 participants; 240 in yoga groups and 183 controls) were analyzed (Table 1a).³⁸⁻⁴³ Four studies provided detailed asana lists with repetitions and duration, while 2 did not describe the asana (Table 1b). All studies reported greater benefits from yoga therapy, though 2 found similar (non-significant, $P > .050$) effects to controls (37 patients). The authors did not explicitly mention any yoga-related adverse effects in the studies. Control groups included self-care approaches (passive controls) or drugs (active controls), which may influence outcome comparisons. Both objective measures (e.g., EMG, heart rate) and self-reported outcomes (e.g., pain, anxiety) were assessed. Yoga for headache showed greater improvements in measurable outcomes (temporal muscle activity, medication frequency, heart rate, sympathovagal

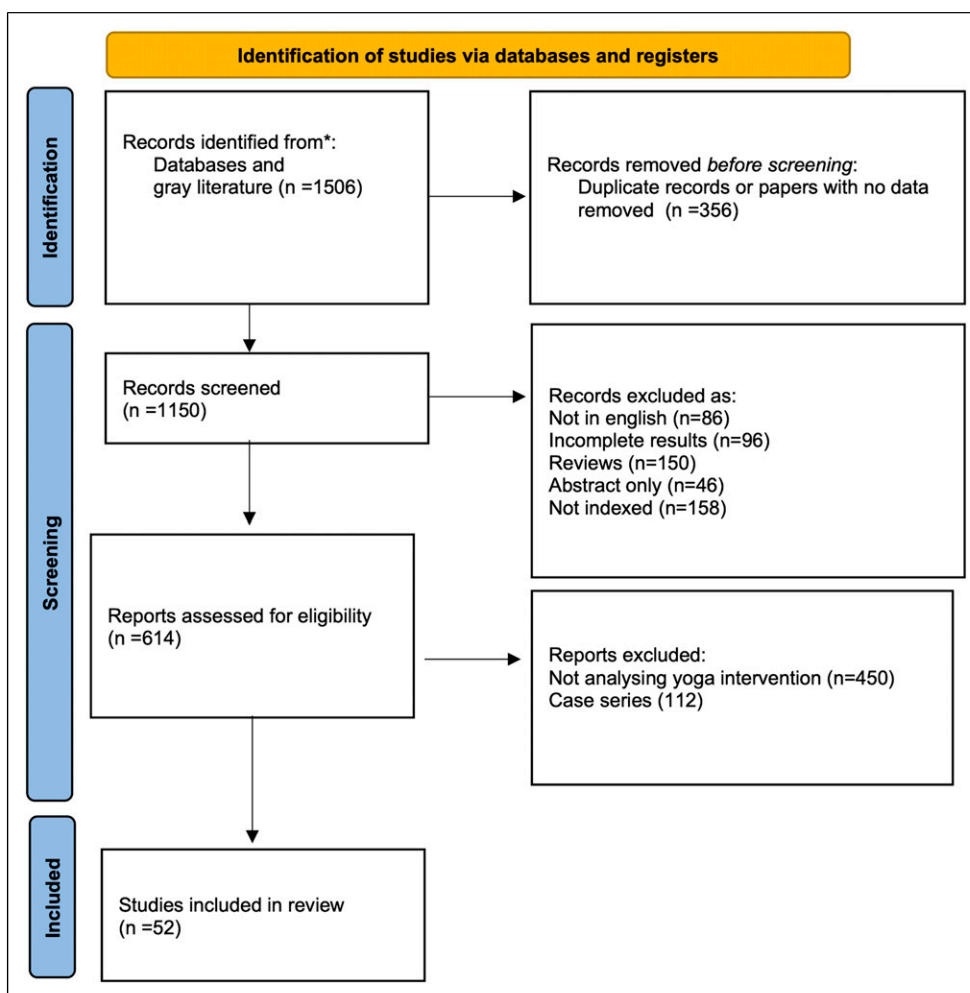


Figure 1. Flowchart of Study Identification, Screening, and Inclusion in the Review

Table 1a. Effect of Yoga For Head and Neck MSDs

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Tension headache	RCT	50 (18-58) 32.1	Class 45 min, 1/week	8 weeks (360 min) Evaluation at 1 and 8 weeks	No intervention (20)	The percentage of self-reported pain relief was 91% in yoga group and 36% in controls. A higher improvement in self-reported headache duration, frequency and intensity was observed in yoga group towards control with no intervention ($P < .05$). Main outcome: VAS and calculated headache index	Y	Kiran et al 2014 (Q4) ³⁸
Tension headache	RCT	21 (15-45) not reported	Class 180 min, 5/week	2 weeks (1800 min)	NSAID group (6), myorelaxant group (3), no intervention (7)	Yoga-based interventions induced a significant decrease of temporalis muscle electromyography activity during rest and mental activity ($P = .03$). Self-reported pain significantly decreased ($P = .02$) in yoga group and in myorelaxant group ($P < .05$). Main outcome: VAS and EMG amplitude	Y	Bhatia et al 2007 (Q4) ³⁹
Tension headache	RCT	72 (18-60) 34.0	Class 60 min, 5/week	12 weeks (3600 min)	Self-care group (educational sessions) (36)	Self-reported headache intensity ($P < .001$), frequency ($P < .001$), pain rating index ($P < .001$), affective pain rating index ($P < .001$), total pain rating index ($P < .001$), self-reported anxiety and depression scores ($P < .001$) and symptomatic medication use ($P < .001$) were significantly lower in yoga group. Main outcome: VAS and mc gill pain questionnaire	Y	John et al 2007 (Q1) ⁴⁰

(continued)

Table 1a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Chronic neck pain	RCT	56 (18-50) 38.7	At home 10 repetition per day, 7/week	6 weeks session duration not reported	Pilates or isometric exercises (38)	Self-reported disability, depression, and quality of life improved with similar trend and no significant differences ($P > .05$) in all yoga, pilates and isometric exercises groups. Significant increase of semispinalis capitis muscle thickness was observed through magnetic resonance only in pilates group ($P = .022$). Main outcome: McGill pain scale, muscle morphology	Similar	Ulug et al 2018 (Q1) ⁴⁴
Nonspecific neck pain	Prospective	38 (15-25) 20.8	Class 60 min, 2/weeks	8 weeks (960 min)	No intervention (20)	Yoga treatment led to a significant decrease in neck pain intensity at motion compared with no intervention control group ($P < .001$). Significant differences in neck flexion, extension, right and left lateral flexion, and right and left rotation ($P < .001$) were detected. Main outcome: VAS	Y	Kim et al 2017 (Q1) ⁴⁵
Neck pain	RCT	56 (18-65) 58	Class 60 min, 1/week	12 weeks (720 min) Evaluation at 6 and 12 weeks	No intervention or pilates (37)	Both pilates and yoga significantly reduced neck disability and self-reported pain compared with no intervention control groups ($P < .05$). No improvements in range of movement or posture were found ($P > .05$) Main outcome: Neck disability index (NDI)	Similar	Dunleavy et al 2016 (Q1) ⁴⁶

(continued)

Table 1a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Neck pain	RCT	51 (18-60) 47.8	Class 90 min, 1/week	9 weeks (810 min)	Usual medical care (self-care booklet) + at home stretching and strengthening exercises (10 min, 7/day) (26)	Yoga group experienced a significantly greater reduction in self-reported pain intensity ($P < 0.05$), neck disability ($P < 0.05$) and increase of range of motion compared with the exercise group ($P < .05$). Self-reported quality of life ($P < .05$), emotional social functioning ($P < .05$), emotional role functioning ($P < .05$), mental health significantly improved for yoga group ($P < .05$). Main outcome: VAS and NDI	Y	Cramer et al 2013 (Q1) ⁴⁷
Neck pain	RCT	77 (18-60) 47.9	At home 90 min, 1/week	9 weeks (810 min) Evaluation at 4 and 9 weeks	No intervention (38)	Self-reported pain intensity ($P < .05$), neck disability ($P < .05$), pain at motion ($P < .05$) and self-reported quality of life improved in yoga group ($P < .05$). Main outcome: VAS and NDI	Y	Michalsen et al 2012 (Q1) ³¹

Similar: Improvement similar to the control; Partial: improvement in some parameters compared to the control. Three studies on headache⁴¹⁻⁴³ are not reported in the table as the causes have not been explicitly stated despite muscular tension is a frequent trigger factor.

Table 1b. Yoga For Head and Neck MSDs

Yoga style	Yoga intervention (Asana, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Rajyoga	Rajyoga meditation. (No Asana reported)	Not reported	20-year expert yoga practitioner	Kiran et al 2014 (Q4) ³⁸
Unspecified	Shavasana and Pranayama: Bastrika, Nadi Shuddi, Bhramari breathing (dog breathing, tiger breathing, hands in and out breathing, hands interlocked, kept on chest, stretching 3 position breathing, ankle stretch breathing). Relaxing and loosening exercises: Neck rolls, shoulder rotation clockwise and anti-clockwise, elbows fold in and out, wrist movements, close and open fist, stretch fingers, rotate arms alternatively, twist body at waist, sideways bend-alternate sides, rotate knees clockwise and then anti-clockwise, toes pointing outwards-up and down, sideways, clockwise and anti-clockwise ankle rotation. Asana: Ardha Chakrasana, Padahastana, Ardha Katichakrasana, Vrikshasana, Ardhamatsyendrasana, Paschimanasana, Konasana, Makarasana, Bujangrasana, Dhanurasana, Uttitapadasana, Sarvangasana, Matsyasana, Setubandhasana, Pawanmuktasana. (Table: Detailed list of Asana, movement/exercises with detailed duration and number of repetition)	Not reported	Not reported	Bhatia et al 2007 (Q4) ³⁹
Pranayama Kyria	Yoga postures (postures focus mainly on stretching of neck, shoulder, back muscles followed by relaxation, toning, strengthening, and flexibility). Pranayama, relaxation, Kyria. (No Asana reported)	Not reported	Trained yoga therapist	John et al 2007 (Q1) ⁴⁰
Iyengar yoga	Adho Mukha Virasana, Tadasana, Virabhadrasana, Chair Bharadvajasana. (Paragraph: List of 5 Asana)	Not reported	Not reported	Ulug et al 2018 (Q1) ⁴⁴
Iyengar yoga and Greeva Sanchalana	Shavasana, Greeva Sanchalana (neck movements: Flexion of neck, extension of neck, right lateral flexion of neck, left lateral flexion of neck, right rotation of neck, left rotation of neck), Shavasana (Figure: Detailed list of Asana, their repetition and duration)	3 minor events (mild dizziness during neck motion)	Bihar yoga barathi yoga instructor	Kim et al 2017 (Q1) ⁴⁵
Hatha yoga	Mountain pose, happy baby, cat-cow, table, child, downward facing dog, upward facing dog, thread the needle, half camel, mountain, warrior I, warrior II, triangle, extended side angle, tree, airplane, cobra, fish, supine twist, boat, bridge, Shavasana. (Supplementary materials: Detailed protocol and asana images)	0 adverse events	Physiotherapist & yoga therapist	Dunleavy et al 2016 (Q1) ⁴⁶
Iyengar yoga	Bharadvajasana, Setu Bandha Sarvangasana, Shavasana, Adho Mukha Svanasana, Adho mukha virasana, Utthita parshvakonasana, Utthita trikonasana, Tadasana, Svastikasana, Supta Padangusthasana, Ardha Uttanasana, Vajrasana, Urdhva hastasana, Virabhadrasana II. (Table and Figure: Detailed list and Asana images)	11 minor events (8 pain increases, 3 limb pain, migraine, vertigo)	Certified Iyengar yoga instructor	Cramer et al 2013 (Q1) ⁴⁷
Iyengar yoga	Savasana, Adho Mukha Svanasana, Tadasana, Parsva Hastasana, Urdhva Hastasana, Urdhva Baddha Anguliasana in Tadasana, Gomukhasana in Tadasana, Utthita Hasta Padasana, Parsva Hasta Padasana, Utthita Trikonasana, Virabhadrasana II, Utthita Parsvakonasana, Virabhadrasana I, Parsvottanasana upright, Parsvottanasana concave, Prasrita Padottanasana concave, Sirsasana Therapeutic poses: Uttanasana Konkav, platform neck curvature Urdhva Baddha Anguliasana, Bharadvajasana, Ardha Uttanasana, Viparita Ardha Hastasana, Sarvangasana, Viparita Karani Sarvangasana, Adho Mukha Svastikasana, Savasana. (Supplementary materials: Detailed list of Asanas)	1 minor event (mild low back pain)	Qualified yoga therapist & physician	Michalsen et al 2012 (Q1) ³¹

Table 2a. Effect of Yoga for Shoulder, Hand and Wrist MSDs and Upper Crossed Syndrome

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Frozen shoulder	RCT	40 (35-60) 45.4	At home 15 min, 3/week	4 weeks (200 min)	Physiotherapy (hot packs, passive joint mobilization, passive stretching for shoulder) (20)	Yogasana significantly improved shoulder abduction mobility ($P = .03$), shoulder flexion ($P = .15$), and shoulder internal rotation ($P = .07$) compared with physiotherapy control group. Main outcome: Disabilities of the arm, shoulder and Hand (DASH)	Y	Pitchai et al 2020 (Q2) ⁴⁸
Frozen shoulder	RCT	72 (35-65) 49.61	At home 30 min, 7/week	4 weeks (840 min) evaluation at 1, 2 and 4 weeks	NSAIDs and physical therapy (36)	Yoga treatment showed a similar improvement in self-reported pain ($P > .05$) and disability scores ($P > .05$) when compared with NSAIDs and physical therapy control group ($P > .05$). Main outcome: Shoulder pain and disability index (SPADI).	Similar	Jain et al 2019 (Q2) ⁴⁹
Shoulder disabilities	RCT	23 (60-80) 68.7	Class 30 min, 1/week	8 weeks (240 min)	No intervention (12)	Sauna yoga did not significantly improve lateral flexibility of the spine, shoulder flexibility, strength in lower extremities (sit to stand test) ($P > .05$). Significant improvement in balance abilities (chair sit and reach test) ($P < .05$) and self-reported quality of life ($P < .05$). Main outcome: Chair sit and reach test, shoulder disability	Partial	Bucht et al 2019 (Q1) ⁵⁰
Shoulder pain	RCT	42 (18-65) 51.5	Class 60 min, 2/week	10 weeks (1200 min)	10-week exercises and booklet (20)	Yoga group showed significant improvements in self-reported shoulder and arm pain towards exercise and booklet control group ($P < .05$). Main outcome: VAS	Y	Eyigor et al 2017 (Q1) ⁵¹

(continued)

Table 2a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Shoulder pain in women with breast cancer	RCT	28 (>18) 55.0	Class 90 min, 3/week + at home 45 min, 7/week	8 weeks (4680 min)	Usual self-care (not specified) (13)	Satyananda yoga treatment improved the lumbo-pelvic posture through the reduction in pelvic obliquity compared with usual self-care control group ($P < 0.05$). Significant increase of strength (in kg) in shoulder abduction in both affected ($P = .042$) and non-affected ($P = .045$) arms was reported. Main outcome: Shoulder and spinal range of motion (ROM), and shoulder muscle strength	Y	Loudon et al 2016 (Q2) ⁵²
Shoulder pain	Prosp	20 (20-30) 22.4	Class 50 min, 3/week	16 weeks (2400 min)	No exercises (10)	Hatha yoga exercise induced a significant decrease in plasma malondialdehyde (oxidative stress biomarker) concentration ($P < .05$) and a significant increase in plasma superoxide-dismutase (endogenous antioxidant enzyme) activity ($P < .05$) Main outcome: MDA and SOD activity	Y	Ha et al 2015 (Q2) ⁵³
Upper crossed syndrome	Prosp	15 (45-61) 53.1	Class 30 min, 3/week	8 weeks (720 min)	No control group	Iyengar yoga intervention led to a significant increase in the cervical ($P < .001$) and shoulder ($P < .005$) angles , and a significant decrease in thoracic flexion angle ($P < .001$) towards baseline time. Main outcome: Cervical, angle, and thoracic flexion angles	Y	Sohrabi et al 2020 (Q4) ⁵⁴
Carpal tunnel	RCT	42 (24-77) 48.9	Class 60 min, 2/week	8 weeks (960 min)	Standard wrist splint with a metal insert (20)	Hatha yoga caused self-reported pain reduction ($P < .05$), significantly improvement in grip strength (Kg) ($P < .05$) and in phalen sign (wrist flexion test) ($P < .05$). No differences in self-reported sleep disturbance ($P > .05$), tinel sign , sensory and motor nerve conduction time ($P > .05$) compared with wrist splint. Main outcome: Grip strength, VAS, wrist flexion test, tinel sign	Similar	Garfinkel et al 1998 (Q1) ²⁰

(continued)

Table 2a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Grip strength in patients with stroke	RCT	32 (30-80) 59.02	Class 60 min, 2/week	8 weeks (960 min)	Standard rehabilitation (not specified) (16)	Hatha yoga decreased significantly the systolic blood pressure ($P = 0.01$), while the diastolic blood pressure decreased but not significantly ($P = 0.11$). Hand grip strength improved significantly in both unaffected ($P = .00025$) and affected ($P = .027$) hands. Standard rehabilitation control group showed no significant change in systolic or diastolic pressure, and no significant change in grip strength for both hands. Main outcome: Blood pressure and hand grip strength	Partial	Lai et al 2023 (Q1) ⁵⁵
Handgrip in healthy patients	RCT	300 (18-22) not reported	At home 15 min, 7/week	4 weeks (420 min)	Cold pressure test (cold water 4°C for 30 s) on opposite hand to test reactivity	Significant increase in pulse rate and blood pressure following the handgrip test ($P < .05$) compared with cold pressure test. Main outcome: Handgrip strength and cold pressor test	Y	Sardesai et al 2020 (Q4) ⁵⁶
Hand grip in healthy students	RCT	60 (12-15) not reported	Class 45 min, 5/week	4 months (900 min)	No intervention (30)	Yoga group showed a significant increase in hand grip strength (Kg) ($P < .0001$) and hand grip endurance (s) ($P < .05$) when compared with no intervention control group. Main outcome: Handgrip strength and handgrip endurance	Y	Rathod et al 2016 (Q3) ⁵⁷
Hand rheumatoid arthritis	RCT	286 (12-50) 31.0 and 13.6	Class 60 min, 5/week	4 weeks (1200 min)	No intervention (143)	Yoga provided significant increase in hand grip strength (Kg) ($P < .002$) and a significant reduction in self-reported drug score (NSAIDs/day) ($P < .013$) in comparison with no intervention control group. Main outcome: Hand grip strength	Y	Dash & Telles 2001 (Q4) ⁵⁸

(continued)

Table 2a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Hand rheumatoid arthritis	RCT	243 (12-50) 31.0 and 13.6	Class 8 hours, 7/ week	4 weeks	No intervention (38)	Yoga training induced a significant increase in motor speed (ms) for repetitive finger movements ($P < .05$), but not in grip strength (Kg) or grip endurance (s) ($P > .05$) compared with no intervention control group. Main outcome: Motor speed and Hand grip strength	Partial	Dash & Telles 1999 (Q4) ⁵⁹

Similar: Improvement similar to the control; Partial: improvement in some parameters compared to the control.

tone) and self-reported outcomes (pain relief, duration, intensity, anxiety, depression, quality of life) compared to drugs or self-care.

3/6 studies (241 patients) showed significantly higher ($P < .050$) effect/relief for headache than drugs (Nonsteroidal Anti-Inflammatory Drugs, NSAIDs, analgesics) in terms of duration, frequency, intensity, anxiety and depression scores, disability and quality of life (Tables 1a and 1b).

However, 3 studies specified tension headache³⁸⁻⁴⁰ while 3 studies vaguely reported migraine.⁴¹⁻⁴³ Then, the data of 3 migraine studies (280 yoga group and 120 controls) have been excluded from the Tables 1a and 1b despite muscular tensions and stress are frequent trigger and coexisting factors.^{84,85}

Neck Pain

Five studies (278 patients) on neck pain were analyzed.^{31,44-47} Four of five studies reported greater improvements (or similar effects in 2 studies) in muscle thickness, disability index, range of motion, sympathetic activity, sympathovagal tone, pain during movement, depression, and quality of life compared to stretching or Pilates (Tables 1a and 1b). Most studies provided detailed protocols with multiple asana, including their repetitions and duration; one study described only 5 asana (Table 1b). Control groups were mainly active (e.g., stretching or Pilates) which can make it appear less effective the observed benefits. Both objective measures (e.g., semispinalis capitis thickness, range of motion) and subjective measures (e.g., pain, quality of life, social functioning) were assessed. Yoga for neck pain showed greater benefits in both measurable outcomes and self-reported improvements than conventional exercises (Table 1a).

Three studies reported some minor adverse effects occurred in yoga group: Kim et al⁴⁵ reported 3 minor episodes of dizziness during neck-movement work, Cramer et al⁴⁷ reported 11 minor complaints (8 pain increases and 3 limb pain, migraine and vertigo events) and Michalsen et al³¹ recorded 1 minor complain (transient mild low-back pain). No serious injuries occurred. It is important to note that one study explicitly reported 0 adverse events,⁴⁴ while in another one, no mention was given.⁴⁶

In detail, the analyzed studies showed important clinical outcomes with significant improvements ($P < .050$) in self-reported headache duration,³⁹ frequency,^{39,41-43} intensity,⁴²⁻⁴⁴ self-reported pain, pain rating index,⁴¹ self-reported anxiety and depression scores,^{41,46} self-reported headache disability,^{42,45} self-reported quality of life, decrease of *temporalis muscle* activity⁴⁰ and *semispinalis capitis* muscle thickness,⁴⁶ decrease in symptomatic medication use⁴¹ and pill count⁴² decrease in heart rate,⁴⁴ sympathovagal tone and sympathetic activity.⁴⁴

Shoulder Pain

Five randomized and 2 prospective clinical studies (240 patients; 121 in yoga groups and 119 controls) on shoulder pain were analyzed (Tables 2a and 2b).⁴⁸⁻⁵⁴ All studies reported significant benefits from yoga therapy; 2 showed partial improvements (significant for some parameters, $P < .050$) in 118 patients, and one found effects similar to controls (21 patients) (Table 2a). No yoga-related adverse effects were reported. Control groups ranged from active comparators (physiotherapy, NSAIDs) to passive controls, influencing observed efficacy. Both objective measures (e.g., mobility, cervical and shoulder angles, spine flexibility, balance, shoulder strength, oxidative stress biomarkers) and self-reported pain scores were assessed. Yoga for shoulder pain demonstrated greater improvements in mobility (abduction, flexion, internal rotation), cervical and shoulder angles, strength, flexibility, balance, disability scores, and stress biomarkers compared to NSAIDs, conventional stretching, physiotherapy, or education. Five of seven studies showed superior outcomes, one (72 patients) found effects comparable to NSAIDs, and one reported partial improvements with limited yoga exercises in a sauna setting. All studies described their protocols in detail.

Hand Disability

Six studies (963 patients) on hand disability were analyzed.^{20,55-59} Three studies did not specify asana names or detailed protocols,⁵⁷⁻⁵⁹ while one study tested only Shavasana.⁵⁶ Control groups included rehabilitation programs or no intervention, introducing variability. Objective measures such as nerve conduction and handgrip strength were often combined with self-reported outcomes. Four of six studies reported significant improvements (handgrip strength and endurance, flexion test, sensory and motor nerve conduction, systolic and diastolic blood pressure, pulse rate), with effects comparable to surgical intervention in 1 study and partial benefits in one Hatha yoga trial with limited asana (Table 2a). No yoga-related adverse effects were reported (Table 2b). Yoga for wrist pain produced greater improvements in measurable outcomes (e.g., mobility tests, grip strength and endurance, nerve conduction time, motor speed, diastolic blood pressure) and self-reported pain compared to rehabilitation or no intervention.

Back Pain and Disorders

We reviewed 11 randomized clinical trials (1 pilot study), with a total of 1009 subjects (474 yoga group and 535 controls) (Table 3a).^{23,28,60-73}

The detail of asana (Sanskrit name or its English translation/description with precise/unequivocal identification of a posture) included in the protocol is not reported in 2 studies (Table 3b).^{64,69} Most of the studies introduced several postures involving the three-dimensional mobility of the spine by extensions, flexions and twists, for the complete

Table 2b. Yoga For Shoulder, Hand and Wrist MSDs and Upper Crossed Syndrome

Yoga style	Yoga intervention (Asana, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Unspecified	Brahma Mudra, Skandha Chakra, Parvattasana, Yoga Mudrasana, Gomukhasana (Figure: Images of the Asanas)	0 adverse events	Not reported	Pitchai et al 2020 (Q2) ⁴⁸
Iyengar yoga	Tadasana, Utkatasana, Ardha Uttanasana, Virabhadrasana I-II, Vrikshasana, Utthita Trikonasana, Utthita Parsvakonasana, Parsvottanasana, Darnikasana, Adho-Mukha Svanasana, Urdha-Mukha Svanasana, Parivrtta Trikonasana, Parivrtta Parsvakonasana, Salabhasana, Salamba Bhujangasana, Dhanurasana, Ardha Urdhva Dhanurasana, Dandasana, Gomukhasana, Pashimottanasana, Parivrtta Pashimottanasana, Baddha Konasana, Upavistha Konasana, Marichyasana, Anantasana, Setu Bandha Sarvangasana, Sarvangasana, Viparita Karan (Tables: Lists of Asanas)	0 adverse events	Not reported	Jain et al 2019 (Q2) ⁴⁹
Unspecified	Tadasana, Tiryakatadasana, Katichakrasana, Trikonasana, Ardhakatichakrasana, Dwikonasana, Ardachakrasana, Natarajasana (Table and Figure: List and images of Asanas)	0 adverse events	Not reported	Bucht et al 2019 (Q1) ⁵⁰
Unspecified (in sauna room at 50°C)	Modified eagle pose, modified sun salutation, modified warrior pose, spine rotations, core 1 and core 2, modified lotus pose (Paragraph: List of Asanas)	Not reported	Not reported	Eyigor et al 2017 (Q1) ⁵¹
Unspecified	Standing poses: Mountain pose (Tadasana), chair pose (Utkatasana), extended triangle pose (Utthita Trikonasana), extended side angle pose (Utthita Parsvakonasana), warrior 1 (Virabhadrasana 1), warrior 2 (Virabhadrasana 2), tree pose (Vrikshasana) Chest and shoulder opening poses: Raised arms pose, arms overhead and parallel (Urdhva Hastasana), cow face pose (Gomukhasana), bridge pose (Setu Bandha Sarvangasana), supine pectoralis muscle stretches on a blanket, supine twists (Paragraph: List of Asanas)	0 adverse events	Certified trainer	Loudon et al 2016 (Q2) ⁵²
Satyananda yoga	Greeva Sanchalana, Utthanpadasana-variation, Supta Pawanmuktasana, Skandha Chakra, Naukasana-variation combined with Namaskarasana-variation of arms, Akarna Dhanurasana-variation, Supta Udarakarshanasana variation, Supta Pawanmuktasana, Nauka Sanchalanasana, Akarna Dhanurasana, Rajju Karshanasana-variation, Tadasana-variation, Trikonasana-variation, Kati Chakrasana, Marjariasana-variation, Eka Pada Pranamasana, Greeva Sanchalana Pranayama and meditation (Paragraph: List of Asanas, referring to a previous paper)	Not reported	Not reported	Ha et al 2015 (Q2) ⁵³
Unspecified	Neck rolls, shoulder circles, ankle circles, stretching exercises Pranamasana, Matsyasana, Simhasana, Bhujangasana, Salabhasana, Ardha Matsyendrasana, Dhanura-Asana, Vrksasana, Halasana, Matsyasana, Savasana, lying leg swinging, Nadishodhna (Table: Detailed list of Asana)	Not reported	Not reported	Sohrabi et al 2020 (Q4) ⁵⁴

(continued)

Table 2b. (continued)

Yoga style	Yoga intervention (Asana, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Hatha yoga	Dandasana, namaste, urdhva hastasana, parvatasana, garudasana, bharadvajasana, tadasana, half uttanasana, virabhadrasana I, urdhva mukha svanasana, namaste, relaxation (Table: Detailed list of Asanas)	0 adverse events	Not reported	Garfinkel et al 1998 (Q1) ²⁰
Hatha yoga	Supine spinal twist pose, knee to chest pose, bridge pose, cobra pose, cat pose, cow pose, hero pose, kneeling pose with balancing on one knee, hare pose, modified tree pose (Supplementary material: Images of Asanas)	Not reported	Registered yoga therapist	Lai et al 2023 (Q1) ⁵⁵
Unspecified	Shavasana (Paragraph: Asana explanation)	Not reported	Not reported	Sardesai et al 2020 (Q4) ⁵⁶
Hatha yoga	Loosening exercises: 5-6 min; quick relaxation technique: 2-3 min; Asana: 15 min; preparation for pranayama: 2-3 min; Kapalbhati: 1-2 min; Pranayama: 6 min; deep relaxation technique: 10 min (Asana not reported)	Not reported	Not reported	Rathod et al 2016 (Q3) ⁵⁷
Unspecified	Selected yoga practice. Pranayama, additional yoga postures for adults, memory games for children which involved chanting verses from ancient Indian texts, and joint loosening exercises for patients with rheumatoid arthritis (Asana not reported)	0 adverse events	Qualified yoga therapist	Dash & Telles 2001 (Q4) ⁵⁸
Unspecified	Yogasana, Pranayama, Kriyas (Asana not reported)	0 adverse events	Not reported	Dash & Telles 1999 (Q4) ⁵⁹

recovery of functional range of motion. Adverse reactions occurred in 5 studies.^{23,28,64,69,70} Six studies explicitly stated that no adverse events occurred.^{62,63,65-68}

These events were generally minor and infrequent, including transient muscle pain or discomfort.^{23,64,69,70} Two studies reported disk herniation.^{23,28}

The effectiveness of yoga protocols was assessed against various controls, including conventional therapeutic exercises (stretching)^{23,65,69-71} education/counseling/self-care,^{23,63,64,67,70,71} and pharmacological treatments (NSAIDs, acetaminophen, opioids, muscle relaxants) in one study with 90 patients²⁸ (Table 3a). Two studies compared yoga to unspecified standard/usual care,^{66,68} and one study lacked a control group. The heterogeneity of control interventions -from educational programs (passive) to drug therapy (active) - may influence the perceived benefits. Both objective outcomes (e.g., biomarkers, spinal mobility) and subjective outcomes (e.g., pain, stress) were evaluated.

All the studies reported significant benefits ($P < .050$) resulting from the yoga therapy, just 1 study (228 patients)²³ of them reported a partial improvement ($P > .050$) and 2 studies (97 patients)^{67,72} found similar benefits to controls (Table 3a).

Disk Herniation

Three prospective clinical trials (281 patients) on yoga for spinal disc diseases reported greater benefits for pain and disability compared to education or no intervention (Table 3a). One study noted minor adverse events, including transient muscle pain, an ankle sprain, and a gluteal sprain (Table 3b).⁶⁰ One study⁷¹ explicitly stated that no adverse events occurred, whereas another 1 study did not provide any information regarding adverse events.³⁰

Control groups consisted of education or no intervention, representing passive comparators. Objective measures such as pain scores and functional tests were complemented by self-reported outcomes. In one study, the asana details (Sanskrit name or clear posture description) were not reported,⁶² while the other 2 provided detailed protocols with multiple asana targeting low back mobilization.^{60,61} Yoga protocols were compared with education⁶⁰ or no intervention,⁶² while 1 study lacked a control group.⁶¹

Hip and Leg-Knee Disorders and Pain

We found 6 randomized clinical articles and 2 prospective studies, with a total of 569 subjects (327 yoga group, and 242 controls) (Table 3a).^{30,32,72,77}

Two studies on hip pain (total 63 patients) were analyzed;^{30,72}

The protocols were deeply detailed and included a wide explanation of performed asana. Only minor yoga adverse effects (transient leg discomfort) were reported in one investigation (Table 3b).⁷²

All reported greater benefits resulting from the yoga therapy, just 3 studies of them reported a partial (non-significant $P > .050$) improvement (154 patients) (Table 3a).

2/2 studies showed significant improvements ($P < .050$) of flexibility (split and hip extension), balance, stiffness, and some reduction of pelvic ante-version in addition to significant improvements of self-reported physical and psychological parameters (Tables 3a and 3b). The studies used active controls (e.g., physiotherapy) and passive comparators. Both measurable outcomes (e.g., flexibility, osteoarthritis index) and subjective assessments were reported.

Six studies (total 506 patients) on knee pain and disability were analyzed^{32,73-77}; The intervention protocol was detailed in 5 studies, while one trial did not report asana names and the description of the protocol was vague.⁷⁴ Minor adverse reactions (13 patients with transient muscle pain) were recorded in just one investigation.³² One study explicitly stated that no adverse events occurred,⁷³ while 4 studies did not provide any information regarding adverse events.^{74,76,77}

4/6 studies reported significant betterments of stiffness and flexibility (2/6 studies), walking and physical performance, osteoarthritis index, in addition to significant improvements of self-reported parameters and psychological health (Tables 3a and 3b).

Generalized Arthritis

We included 6 randomized clinical trials, with a total of 388 subjects (196 yoga group, and 192 controls) (Table 4a).⁷⁸⁻⁸³ The intervention protocol was detailed in all studies, which reported asana names, intervention frequency and related total duration. Among studies of yoga interventions for generalized arthritis, one reported no adverse effects,⁷⁹ whereas 4 did not provide explicit information on adverse events.^{78,80,82,83} One study reported minor adverse events (muscle pain and nausea) in 19 patients possibly related to the intervention (Table 4b).⁷⁶

In arthritis studies, the control groups were predominantly active pharmacological treatments (Disease-Modifying Antirheumatic Drugs, DMARDs), which may have masked part of yoga's effects. Objective outcomes such as inflammatory markers were evaluated alongside self-reported pain and mood improvements (Table 4a).

Yoga practice for 6-12 weeks produced significant improvements of self-reported pain, swelling, fatigue, mood, and induced a significant reduction of inflammatory markers.⁷⁸⁻⁸³ All the studies reported significant benefits resulting from the yoga therapy. In detail, 4/6 studies reported significantly higher benefits vs antirheumatic drugs DMARDs (Table 4a), namely reduction of inflammatory markers (2/6 studies), amelioration of disease activity or clinical disease (2/6 studies) and increase of mind-body communicative markers (1 study) (Tables 4a and 4b). Only one study (n = 26 patients) found similar benefits to the

Table 3a. Effect of Yoga For Spine, Hip and Leg-Knee Disorders and Pain

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Lumbar disc herniation	RCT	48 (18-50) 37	Class 60 min, 2/week	12 weeks (2400 min), Evaluation at 0, 1, 3 and 6 months	Education without exercise (24)	Hatha yoga showed after T3 and T6 months significant improvements in neuropathic pain (DN4) ($P < .001$), neuropathic component of pain (leads assessment of neuropathic symptoms and signs, LANSS) ($P < .001$), low back pain (McGill pain questionnaire for sensory, perception, and likert scores) ($P < .001$), VAS, visual analogue scale ($P < .001$), disability (oswestry disability index, ODI) ($P < .001$), function by mobility of lumbar vertebrae in flexion (modified schober) ($P < .05$) and passive knee extension (PKE) ($P < .001$) tests compared with education. Main outcome: DN4 and LANSS scores	Y	Yildirim et al 2022 (Q1) ⁶⁰
Lumbar spondylitis	Prosp	172 (21-79) 29	Class 60 min, 7/week	4 weeks (1680 min)	No control group	Yogic practices (pawanamuktasana and yoga Nidra) are effective in both self-reported disability ($P < .001$) and self-reported pain ($P < .001$) with a pain reduction of 22.80%–64.04% towards the baseline. Main outcome: RMDQ	Y	Manik et al 2017 (Q4) ⁶¹
Disk extrusion and bulging	RCT	61 (20-45) 36	At home 20 min, 7/week	12 weeks (1680 min)	No intervention (31)	Yoga therapy in patients with disk herniation and sciatica significantly improved self-reported pain ($P < .05$) and self-reported disability scores ($P < .05$) compared with no intervention. Main outcome: RMDQ	Y	Monro et al 2015 (Q2) ⁶²

(continued)

Table 3a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Low back pain	RCT	29 (18-60) 36.9	Class, 60 min, 6/week	2 weeks (720 min)	Self-care, ergonomic and posture advices and booklet (18)	Yoga showed a more significant reduction compared to the control in self-reported pain intensity ($P = .036$), self-reported disability ($P < .05$), self-reported anxiety ($P < .05$), quality of life and depression ($P = .012$). Yoga significantly reduced inflammatory cytokine TNF-α values ($P = .004$) and significantly raised calcitonin gene-related peptide levels ($P = .001$). Differently, beta-endorphins levels were not significantly different ($P > .05$). Main outcome: Pain (VNRS), MODI	Y	Poojari et al 2023 (Q1) ⁶³
Chronic low back pain	RCT	120 (>18) 55.5	Class 75 min, 1/week + 30 min at home max 6/week	12 weeks (3060 min)	Book including education, treatment (unspecified), and self-care (58)	Hatha yoga and education showed similar reductions in back-related disability ($P = 0.39$) and pain ($P = .65$), then no significant differences between groups. However, more yoga participants expressed greater self-reported improvements ($P = .01$) and greater satisfaction (likert scale) ($P = .002$) compared with control. Main outcome: RMDQ, pain (PRS)	Similar	Rosen et al 2023 (Q1) ⁶⁴
Chronic low back pain	RCT	70 (>18) 35.3	Class 60 min 3/week	8 weeks (1440 min)	Hatha yoga group + meditation (35)	Both groups improved kinesiophobia, perceived disability, and stress at the follow-up ($P < 0.05$). Hatha yoga + meditation (control group) showed a more significant reduction ($P < .001$) in kinesiophobia compared with Hatha yoga group. Main outcome: Kinesiophobia (TSK), PANAS, PSS, and RMQ	Y	De giorgio et al 2023 (Q2) ⁶⁵

(continued)

Table 3a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Chronic back pain	Pilot	35 (18-70) 34	Class 60 min, 1/ week + at home 15 min, 1/week	12 weeks (900 min)	No intervention (24)	Yoga intervention improved self-reported physical movement ($P < .05$), self-reported stress levels ($P < .05$), reduced self-reported pain severity ($P < .05$) and self-reported emotion regulation ($P < .05$) towards no intervention control group. Main outcome: Pain severity	Y	Adhilarani et al 2022 (Q2) ⁶⁶
Chronic back pain	RCT	98 (18-65) 42.5	Class 120 min, 5/week	8 weeks (4800 min) Evaluation at 0, 4 and 8 weeks	Standard care (not specified) (48)	Yoga therapy improved self-reported pain ($P < .0001$) and self-reported quality of life ($P < .001$), and significantly increased nociceptive flexion reflex threshold ($P < .0001$) and descending pain modulation ($P < 0.0001$) compared with standard care group. Main outcome: McGill pain questionnaire, VAS	Y	Arya et al 2022 (Q4) ⁶⁷
Chronic pain in elder women	RCT	38 (>60) 66	Class 60 min, 2/week	12 weeks (1440 min) Evaluation at 6 and 12 months	No intervention (19)	Yoga induced significant reductions in self-reported pain ($P < .05$) and improvements of energy, social functioning ($P = .00040$) and quality of life ($P < .05$). Main outcome: Inflammatory markers, brief pain inventory (BPI)	Y	Seguin-Fowler et al 2020 (Q2) ⁶⁸
Chronic low back pain	RCT	70 (18-55) 35.8	Class 35-min, 1/week + at home 30 min, 6/week	6 weeks (1290 min) Evaluation at 6 and 12 weeks	Conventional therapeutic exercises (warm-up, 3 stretching and 5 strengthening exercises) (35)	Hatha yoga showed a significant improvement in self-reported back pain and self-reported disabilities ($P < .05$). The improvements were similar to the therapeutic exercises of control group ($P > .05$), and were maintained until the endline (12 months) Main outcome: RMDQ, VAS	Similar	Neyaz et al 2019 (Q1) ⁶⁹

(continued)

Table 3a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Low back pain	RCT	151 (18-65) 44	Class 60 min, 1/week	8 weeks (480 min)	Usual care (not specified) and educational booklet (75)	Dru Hatha yoga participants showed significant self-reported back pain reductions ($P < .05$) and back related disability ($P < .05$) when compared with usual care control group. Main outcome: RMDQ	Y	Harfield et al 2017 (Q1) ⁷⁰
Chronic low back pain	RCT	80 (18-60) not reported	Class 120 min, 7/week	1 week (840 min) Evaluation at 1 and 7 days	Physical exercises and counseling (40)	Both yoga and physical exercise groups significantly reduced self-reported pain ($P < .05$) and self-reported depression ($P < .001$) scores, and spinal mobility (sit and reach test $P < .05$). Yoga also improved self-reported anxiety ($P < .001$). Main outcome: NRS, state-trait anxiety inventory, beck depression inventory, sit and reach test	Y	Tekur et al 2014 (Q1) ⁷¹
Chronic low back pain	RCT	228 (18-60) 46	Class 75 min, 1/week	12 weeks (900 min) evaluations at 6, 12 and 26 weeks	Conventional stretching exercises (60 min 1/week for 12 weeks) or self-care book (136)	Vinyoga significantly improved self-reported pain ($P < .05$) and self-reported disability ($P < .05$) compared to self-care group, whilst the improvements were similar to stretching group ($P > .05$). Both yoga and stretching showed significant benefits beyond self-care control group on the reported disability at 26 weeks, ($P < .05$). Main outcome: RMDQ, pain numerical rating scale (PNRS)	Partial	Sherman et al 2011 (Q1) ²³
Chronic low back pain	RCT	90 (18-70) 48	Class 90 min, 2/week	24 weeks (4320 min) Evaluations at 0, 12 and 24 months	Self-directed standard medical care (not specified) and drugs (NSAIDS, acetaminophen, opioids, muscle relaxants not specified) (47)	Iyengar yoga group showed significantly greater reductions in self-reported functional disability ($P < .05$) and self-reported pain intensity ($P < .05$) compared with standard medical self-care and drugs. Main outcome: Oswestry disability questionnaire (ODI), VAS, BDI	Y	Williams et al 2005 (Q1) ²⁸

(continued)

Table 3a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Flexibility of the groin and hip	RCT	40 (17-24) 20.3	Class 70 min, 2/week	16 weeks (2240 min)	10 minute/week yoga videos (many styles) (20)	Yoga classes significantly improved flexibility (sit and reach test and splits test) ($P < .05$) and balance (single-limb stance test, romberg test) ($P < .05$) compared to yoga video control group. Main outcome: Sit and reach, romberg, single limb stance, splits	Y	Luo et al 2023 (Q1) ³⁰
Altered hip extension	Prosp	23 (62-83) 70.7	Class 90 min, 2/week	8 weeks (1440 min)	No control (control at baseline)	Hatha yoga practice for 8 weeks led to marked, but not significant, improvements on hip extension stride length increase ($P > .05$) and pelvic ante-version reduction ($P > .05$) compared to baseline. Main outcome: Peak hip extension, average pelvic tilt	Similar	Di Benedetto et al 2005 (Q1) ⁷²
Hip and knee osteoarthritis	RCT	36 (65-85) 71.9	Class 120 min, 5/week	8 weeks (4800 min) evaluations at 0, 4, 8 and 20 weeks	No intervention (18)	Hatha yoga group exhibited significantly greater improvement at weeks in the index of self-reported physical performances ($P = .01$), self-reported pain ($P = .01$), stiffness ($P = .002$) and short physical performance ($P = .03$) towards no intervention. Main outcome: Western Ontario and McMaster universities osteoarthritis index (WOMAC)	Y	Cheung et al 2014 (Q1) ⁷³
Lower extremities osteoarthritis	RCT	112 (>65) 75.9	Class 45 min, 2/week	8 weeks (720 min) evaluations at 0, 4 and 8 weeks	Health education: 45 min 2/ week. (49)	Significant effect of chair yoga on self-reported pain among elder adults with lower extremity osteoarthritis ($P < .05$). Yoga did not significantly reduce self-reported frailty index ($P > .05$). Main outcome: WOMAC	Partial	Park et al 2020 (Q2) ⁷⁴

(continued)

Table 3a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref
Knee osteoarthritis	RCT	53 (>18) 49.2	Class 60 min, 2/week	32 weeks (3840 min)	Not participating at yoga classes (35)	Hatha yoga improved physical (sit and reach test, walking capacity) ($P < .0001$) and psychological health (perceived stress, self-efficacy, positive affect, negative affect) ($P < .001$) and quality of life (physical function, general health, vitality, social function) ($P < .05$). Significantly higher walking capacity for yoga ($P < .05$). Main outcome: SF-36.	Y	Moonaz et al 2015 (Q1) ⁷⁵
Knee pain	RCT	212 (>45) 62	Class 30 min, 3/week	12 weeks (1080 min) evaluations at 0, 12 and 24 weeks	Education (105)	Several yoga styles significantly improved knee stiffness ($P < .05$), self-reported quality of life ($P < .05$) and arthritis indexes ($P < .05$) more than control with education. These improvements were not maintained after 24 weeks. No significant improvement was observed for self-reported knee pain ($P > .05$). Main outcome: WOMAC	Partial	Bennel et al 2022 (Q1) ³²
Patellofemoral pain syndrome	Prosp	63 (40-60) Not reported	At home 30 min, 6/week	4 weeks (720 min)	No control (control at baseline)	Yoga intervention significantly reduced self-reported pain levels ($P < .05$) and improved self-reported patellofemoral joint-related symptoms and function ($P < .05$) in comparison with baseline. Main outcome: NPRS, KOOS-PF (knee osteoarthritis outcome survey - patellofemoral subscale), and SF-36	Y	Nair et al 2022 (Q4) ⁷⁶
Knee pain	RCT	30 (18-65) 41.3	Class 60 min, 3/week	8 weeks (1440 min)	No intervention (15)	Hatha yoga exercises caused a significant decrease in self-reported pain and a significant increase in self-reported knee function ($P < .05$). Main outcome: VAS, KOOS questionnaire	Y	Gasemi et al 2012 (Q3) ⁷⁷

Similar: Improvement similar to the control; Partial: greater improvement in some parameters compared to the control.

Table 3b. Yoga For Spine, Hip and Leg-Knee Disorders and Pain

Yoga style	Yoga intervention (Asanas, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Hatha yoga	Easy pose, child pose, cat-cow, bridge pose, lounge pose, pigeon pose, tree pose, chair pose, triangle pose, plank, side plank, half lord of the fishes, cow-faced pose, Warrior-1, Warrior-2, extended side angle. (Figure: Images of asana)	4 adverse events (1 ankle sprain, 1 gluteal sprain, 2 minor muscle injuries)	A certified yoga instructor with 5 years experience	Yildirim et al 2022 (Q1) ⁶⁰
Pawanamuktasana and Yoga Nidra	Pawanamuktasana series 1: Joint exercises Backward bending series of asana: Makarasana, Bhujangasana, Sarpasana, Saral Salabhasana, Tadasana, Tiriyakatadasana, Kati Chakrasana, Ardha Kati chakrasana Pranayama: Nadisodhana, Bhramari Short relaxation: Yoga Nidra. (Table: List of asanas, their repetition and duration)	Not reported	Not reported	Manik et al 2017 (Q4) ⁶¹
Unspecified	Protocol not reported	0 adverse events	A distinguished orthopaedic surgeon	Monro et al 2015 (Q2) ⁶²
Unspecified	Opening prayer Loosening practice: Finger, wrist, elbow, shoulder rotation, neck movements, hand stretch, ankle stretch, outward and inward stretch, ankle rotation Supine Asana with breathing: Back press, (with mool bandha & Uddiyana bandha), Setubandhasana, Pawanmuktasana lumbar stretch (alternate and both legs), folded leg lumbar stretch (right leg bent, left leg bent, both legs bent) Prone Asana: Makarasana relaxation, Ardha Shalabhasana breathing (half locust pose), Bhujangasana breathing (cobra breathing), Quadrupedia Asana: Tiger breathing, Shashankasana Standing Asana (with breathing): Ardhakati Chakrasana (half waist wheel posture) Ardha Chakrasana (half wheel posture) Meditation (Supplementary material: Detailed list and images of Asanas)	0 adverse events	Not reported	Poojari et al 2023 (Q1) ⁶³

(continued)

Table 3b. (continued)

Yoga style	Yoga intervention (Asanas, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Hatha yoga	Svasana, knee to chest, knee together twist, shoulder opener, mountain, chair twists (standing and seated), cobra, bridge, downward facing dog (and at wall), pelvic tilt, Cat and cow, chair pose, crescent moon, reclining cobbler, locust, child pose, triangle (with and without the wall), sphinx, standing forward bend at wall, extended leg, warrior I. (Paragraph: Asana list reported in a previous paper (Roseen et al 2020))	8 minor events (4 low back pain, 1 shoulder dislocation, 1 muscle soreness, 1 chest pain)	Six yoga instructors that completed 200 hours of yoga teacher training and a minimum of 2 years of teaching experience.	Roseen et al 2023 (Q1) ⁶⁴
Hatha yoga	Marjaryasana/Bitilasana (cat/cow pose), Adho Mukha Svanasana (downward-facing dog pose), Uttanasana (standing forward bend), Malasana (garland pose), Salamba Bhujangasana (sphinx pose), Uthita Balasana (extended Child's), Pavanamuktasana (wind-removing), Supta Matsyendrasana (reclining spinal twist). (Figure: Asanas images were reported)	0 adverse events	One professional with a master's degree holder in clinical psychology, certified yoga	De Giorgio et al 2023 (Q2) ⁶⁵
Hatha yoga, Viniyoga, Iyengar yoga.	Asana not reported. 15 min of basic postures. Standing poses for about 15 min. Floor poses for about 20 min. 5-7 min of complete relaxation in savasana	0 adverse events	A qualified yoga therapist	Adhikari et al 2022 (Q2) ⁶⁶
Unspecified	Standing asana: Tadasana, Triyak Tadasana, Trikonasana, Samikonasana. Sitting Asana: Shashakasana, Paschimanasana, Seubandhasana, Marjariasana. Lying on stomach Asana: Makarasana, Bujangasana, Shalabhasana. Lying on back Asana: Pavanmuktasana regulated breathing, Sarvangasana, Setubandhasana, Markatasana, Shavasana (Table: List of Asanas, their repetition and duration)	0 adverse events	A qualified yoga therapist	Arya et al 2022 (Q4) ⁶⁷
Unspecified	Three-part breath (Sukhasana), seated side flow, cat/dog, leg extension, hip circles, rocking flow, lunge twist flow, mountain pose, greaser arms, bird wings, warrior I, warrior 2 to peaceful warrior, boat pulse, bridge kriya, supine and twist flow, legs up the wall, supported reclined bound angle, savasana. (Supplementary: Detailed list and images of Asana)	0 adverse events	A certified yoga instructor with cardiopulmonary resuscitation certification and 25 years of teaching experience in yoga	Seguin-Fowler et al 2020 (Q2) ⁶⁸
Hatha yoga	Sithilikaran Vyayama, Supta Udarakarshanasana, Shavaudarakarshanasana, Supta Pawanmuktasana, Ustrasana, Bhujangasana, Salabhasana, Setubandasana, Savasana Pranayama: Nadi suddhi, Bhramari, meditation, Savasana (Table: List of Asana and their duration)	3 minor events (increased pain)	A trained yoga therapist	Neyaz et al 2019 (Q1) ⁶⁹

(continued)

Table 3b. (continued)

Yoga style	Yoga intervention (Asanas, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Dru yoga (Hatha yoga)	Each session was structured in 4 phases: Activation exercises, energy block release sequences, back care postures and relaxation techniques. (Asana not reported)	1 minor event (1 mild muscle spasm)	6 instructors who had completed a 200-hour Dru yoga training course accredited internationally with the yoga alliance.	Hartfield et al 2017 (Q1) ⁷⁰
Unspecified	Pavanamuktasana, Supta Pawanamuktasana, Jhulana Lurkhanasana, Ardha Navasana, uttanapadasana, Sethubandhasana, Supta Udarakarshanasana, Shavaudarakarshanasana, Bhujangasana Shalabhasana, Vyaghra Svasa, Shashankasana, Ardha Chakrasana, Prasrita Pada Hastasana, Ardha kati Chakrasana (Tables: Lists of Asanas)	0 adverse events	Not reported	Tekur et al 2014 (Q1) ⁷¹
Viniyoga	Cobra posture, knee to chest posture, wheel posture, bridge posture, supine butterfly, extended leg posture, warrior posture, standing forward bend, kneeling forward bend, chair posture, lying twist, swimmer posture, extended side stretch, lunge, kneeling lateral posture, standing lateral posture (Paragraph: Asana protocol reported in a previous study)	14 adverse events (13 increased back pain, 1 herniated disk)	2 instructors with at least 500 hours of Viniyoga training	Sherman et al 2011 (Q1) ²³
Iyengar yoga	Tadasana, Urdhva hastasana, feet together Uthita padmasana, Uthita hasta padasana, Parsva hasta padasana, Uthita parsvakonasana, Uthita trikonasana, Virabhadrasana II, Ardha chandrasana, Prasrita padottanasana, Hands on blocks Parsvottanasana, Parivrtta trikonasana, Bharadvajasana-seated on chair, Uthita Marichyasana Dandasana, Marichyasana III, Adho mukha virasana-with bolster under abdomen, Savasana II Supine with lower legs on chair seat, Savasana prone Supta padangusthasana II, prone Supta padasana, Supta urdhva hastasana, Supta padangusthasana I and II, Straight leg Supta pavanmuktasana. Urdhva prasarita, Padasana at the wall, Pavanmuktasana-over bolster on 2 chairs, Parsva pavanmuktasana, Uthita hasta padangusthasana I and II . Straight leg Ardha uttanasana. Adho mukha svanasana.	1 adverse event (1 herniated disk)	A yoga instructor. Qualification not specified	Williams et al 2005 (Q1) ²⁸

(Table: Detailed list of Asana)

(continued)

Table 3b. (continued)

Yoga style	Yoga intervention (Asanas, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Hatha, aerial, ashtanga, Iyengar, flow, yin and dance yoga	Standing postures: Utkatasana (chair pose), Utkatasana (standing forward bend), Yrksasana (tree pose), Garudasana (eagle pose), Natarajasana (dancer pose), Virabhadrasana I (warrior pose), Virabhadrasana II (warrior II), Virabhadrasana III (warrior III), Uttitha Trikonasana (triangle pose), Parivrtta Baddha Parsvakonasana (revolved side angle pose) Sitting postures: Dasana (staff pose), Janu Sirsasana (Head-to-knee pose), Parivrtta Janu Sirsasana (revolved Head-to-knee pose), Baddha Konasana (bound angle pose), Gomukhasana (cowface pose), Navasana (boat pose), Ardha Matsyendrasana (half lord of the fishes pose), kneeling postures balasana (Child's pose), Supta Virasana (reclining hero or heroine pose), Ustrasana (camel pose), Eka Pada Rajakapotasana (one-legged king pigeon pose), Parighasana (gate pose), Simha asana (lion pose) Prone postures: Savasana (corpse pose), Apanasana (knees-to-chest), Setu Bandha Sarvangasana (bridge pose), Setubandha Sarvangasana (shoulder stand), Viparita Karani (legs-up-the-wall pose), Halasana (plow pose), Jathara Parivrtti asana (belly twist) Supine postures: Bhujangasana (cow pose) Dhanurasana (low pose) Salabhasana (locust pose) (Table: List of Asana and their duration)	Not reported	A qualified yoga therapist	Luo et al 2023 (Q1) ³⁰
Hatha yoga	Asanas: Centering (in cross-legged position), finger, and toe weaving, Virasana (hero pose), Vajrasana (thunderbolt pose), tadasana (mountain pose), table pose (including leglifts), Salabasana (locust pose), Padangusthasana (holding the big toe pose), supta padangusthana (holding the big toe lying down pose), Uttitha Hasta padangusthasana (extended holding the big toe pose), Supta Baddha Konasana (lying down bound angle pose), Eka Pada Bhikasana (1-leg frog pose), and Shavasana (corpse pose). Asana specifically targeting the pelvic region: Rajakapotasana (pigeon or hip stretch pose), Parsvotanasana (flank stretch), virabhadrasana (warrior pose), Surya namaskar (modified sun salutations using a chair or a prop). (Figures: Asana list and images were reported)	2 minor events (1 increased leg discomfort, 1 not-reported discomfort)	Not reported	Di Benedetto et al 2005 (Q1) ⁷²

(continued)

Table 3b. (continued)

Yoga style	Yoga intervention (Asanas, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Hatha yoga	Asana in seated, supine, and standing positions; Pranas (breathing); meditation. Key yoga postures included, mountain pose, warrior I and 2 poses, tree pose, chair pose, easy seated pose, bound angle poses, open angle pose, half locust variation, bridge pose, standing forward fold, reclining hamstring stretch, reclining twist, and relaxation pose. (Paragraph: List of Asanas)	0 adverse events	Designed by a registered yoga therapist and reviewed by yoga researchers and yoga master	Cheung et al 2014 (Q1) ⁷³
Chair yoga	Physical postures, breathing, deep relaxation, and meditation, deep breathing techniques, stretching and physical poses, and relaxation/mindfulness (Asana not reported)	Not reported	Qualification non specified	Park et al 2020 (Q2) ⁷⁴
Hatha yoga	King dancer, table, easy pose, extended leg pose, downward dog, prayer position, chair pose, warrior I, low lunge. (Appendix: List of Asanas their repetition and duration)	Not reported	Two yoga therapists with 10-year experience	Moonaz et al 2015 (Q1) ⁷⁵
Hatha yoga, Vinyasa lyengar yoga on a chair or freebody	Warm-up, breathing exercises, and yoga postures to warm up the core and lower extremity muscles. Static and dynamic yoga postures to activate, strengthen, and stretch the muscles of the core and lower extremities. Gentle stretches for activated muscles, breathing practices, and relaxation exercises. (Supplementary material: Detailed list and images and video of Asana)	13 minor events (13 musculoskeletal pain)	A physiotherapist & yoga teacher	Bennel et al 2022 (Q1) ³²
Unspecified	Shithilikarana Vyayama, Tadāsana, Dandāsana, Janushirsāsana, Ardha Salabhasana, Sarpāsana, Uthitasana, Setubandhasana, Utkatasana, Virabhadrasana I, II, Makarāsana (Figures: Asanas images were reported)	Not reported	Not reported	Nair et al 2022 (Q4) ⁷⁶
Hatha yoga	Asana (movement), Pranayama (breathing) and meditation (relaxation) practices. (Asana not reported)	Not reported	A qualified yoga therapist	Gasemi et al 2012 (Q3) ⁷⁷

Table 4a. Effect of Yoga For Generalized Arthritis

Disease	Clinical study	N of patients, age range & mean age	Yoga session duration (min) and frequency (week)	Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref (quartiles)
Generalized arthritis	RCT	57 (18-75) 52.9	Class 60 min, 2/ week	6 weeks (720 min) Endpoints at 6,12,24 weeks	Educational lectures on arthritis-related topics (27)	Significant improvements in self-reported fatigue ($P < .05$) and mood ($P < .05$) were observed in yoga group at postintervention (6 weeks) and follow-up (12 and 24 weeks). Main outcome: Health-related quality of life (SF-36)	Y	Puksic et al 2021 (Q1) ⁷⁸
Generalized arthritis	RCT	66 (18-60) 45.1	Class 75 min, 1/ week	8 weeks (600 min)	Usual medical care with drugs (disease-modifying antirheumatic drugs, DMARDs) (33)	Ashtanga yoga group significantly reduced inflammatory markers (TNF-alpha, TGF-beta, IL-6) ($P < .001$) and increased mind-body communicative markers (derived neurotrophic factor, dehydroepiandrosterone, b-endorfin, Sirtuin 1) ($P < .001$) compared with control group with drugs. Main outcome: DAS28, inflammatory markers	Y	Gautam et al 2020 (Q1) ⁷⁹
Generalized arthritis	RCT	166 (30-60) 41.3	Class 30 min, 3/ week	12 weeks (1080 min)	Standard care and drugs (83)	Disease activity markers (IL-1-a, IL-6, TNF- α , and cortisol) significantly decreased in both groups after 12 weeks. Significantly higher decrease of IL-1-a and cortisol in yoga group than control group with drugs ($P < .05$). Main outcome: DAS28, inflammatory markers, cortisol	Y	Ganesan et al 2020 (Q1) ⁸⁰
Generalized arthritis	RCT	26 (>18) 50	Class 90 min, 2/ week	12 weeks (2160 min)	Usual care and antirheumatic drugs (13)	Yoga program improved self-reported pain and disability (fatigue, clinical disease , anxiety, depression, questionnaire disability, insomnia severity, visual analogue scale) ($P < .05$) compared with drug control group. The adverse events were minor in yoga group. Main outcome: VAS, ISI, HAQ-DI, functional disability	Similar	Ward et al 2017 (Q2) ⁸¹
Generalized arthritis	RCT	26 (16-35) 29.9	Class 90 min, 2/ week	8 weeks (1400 min)	No intervention (15)	Iyengar yoga intervention improved self-reported quality of life ($P < .05$), pain disability ($P < .05$) and mood ($P < .05$) compared with control group with no intervention. Main outcome: PedsQL, VAS	Y	Evans et al 2013 (Q1) ⁸²

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Table 4a. (continued)

Disease	Clinical study	N of patients, age range & mean age	Yoga session		Study duration (total minutes)	Control (n patients)	Findings and main measured outcomes	Yoga therapy benefit	Ref (quartiles)
			duration (min)	and frequency (week)					
Generalized rheumatoid arthritis	RCT	47 (>18)	44	Class, 60 min, 1/ week	8 weeks (480 min)	Standard rheumatology care (DMARDs) (21)	Statistically significant improvements of self-reported parameters (quality of life) ($P = .014$.) and disease activity (swelling $P = .003$, soreness $P = .021$ and erythro sedimentation rate $P < .05$). Patients in raja yoga group were able to decrease or discontinue medications. Main outcome: HAQ-DI, hand grip strenght	Y	Badsha et al 2009 (Q1) ⁸³

Similar: Improvement similar to the control; Partial: greater improvement in some parameters compared to the control.

Table 4b. Yoga For Generalized Arthritis

Yoga style	Yoga intervention (Asanas, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Unspecified	Sarva Hita Asanas Part I: Anandasana, Abdominal Breath Exercise, Stretching the Body, Turning the Head, Twisting with Legs Bent, Rolling Sideways with Legs Bent, Shoulder Raising, Shoulder Circling, Shoulder Circling with Arms Bent, Crossing the Arms above the Head, Bending and Straightening the Arms, Weight Shifting, Tensing the Calf, Anandasana, Pavana Muktasana, Half Butterfly, Marjari, Khatu Pranam, Nadi Shodhana Pranayama Level I (Figure: Images of Asana reported in a reference (external link))	Not reported	A licensed teacher with master qualification	Puksic et al 2021 (Q1) ⁷⁸
Patanjali Ashtanga yoga	Standing: Trikonasana, Katichakrasana, Tadasana, Virabhadrasana, Sitting: Gomukhasana, Paschim-utanasana, Shashankasana, Vakrasana, Prone: Ek-pada-shalabhasana, Bhujangasana, Poonna- shalabhasana, Makarasana, Supine: Utanapadasana, Setubandhasana, Pavanmuktasana, Matsyasana (Table: detailed list of Asana)	0 adverse events	A registered well qualified yoga therapist	Gautam et al 2020 (Q1) ⁷⁹
Unspecified	Warming up: Sukshma vyayama: Purna-bhuja- sakti-vikasaka (exercising muscles controlling the arms), Mani-bandha- sakti-vikasaka (exercising muscles controlling the wrists), Kara-tala- sakti-vikasaka (exercising muscles controlling the palms), janu- sakti-vikasaka (exercising muscles controlling the knees), Gulpha-pada-prstha-pada-tala- sakti-vikasaka, (exercising muscles controlling the ankles and feet) Yogasanas: Tadasana(mountain pose), Katichakrasana (lateral arc pose), Konasana (angle pose), Urdhwa hastottanasana (upstretched arms posture), Pavanamuktasana (wind removing pose), Bhujangasana (cobra pose). Shavasana (corpse pose, palms up) Pranayama: Nadishodhana pranayama (alternate nostril breathing), Chandrabhedhi pranayama (left nostril breathing), Bhramari (humming bee breathing) (Table: List of Asanas, their repetition and duration)	Not reported	Qualified yoga instructor	Ganesan et al 2020 (Q1) ⁸⁰
Unspecified	Pawanmuktasana I + 5-10 supine/seated/standing Asana: Supine: Shavasana, knees to chest, extended leg, hip circles, butterfly Seated: Seated mountain, thunderbolt, cobra, wheel/child's pose, side bend, seated twist Standing: Mountain, half dog, flowing warrior, chair, wide-leg forward bend (Previous protocol study: Detailed list of asana)	19 minor events (19 non-serious nausea and muscle pain)	Qualification non specified	Ward et al 2017 (Q2) ⁸¹
Iyengar yoga	Tadasana Urdhva Hastasana, Tadasana Urdhva Baddha Hastasana, Tadasana Paschim Baddha Namaskarasana, Utthita Trikonasana, Utthita Parsvakonasana, Utthita Ardha Chandrasana, Viparita dandasana with back bender or two chairs and thoracic support, Upavista Konasana, Baddha Konasana, Sukhasana and dandasana Adhomukha Swastikasana, Bharadvajasana, Adhomukha Svanasana, Salamba Sirsasana, Setubandha Sarvangasana, Salamba Sarvangasana, Halasana, Supta konasana, Viparita Karani, Supta Padangusthasana, Supta Baddha Konasana, Savasana (Table: detailed list of Asana)	Not reported	Experienced yoga instructor	Evans et al 2013 (Q1) ⁸²

(continued)

Table 4b. (continued)

Yoga style	Yoga intervention (Asanas, Pranayama)	Yoga-related adverse events	Yoga instructor qualification	Ref
Raja yoga	Standing: Tadasana (palm tree pose), Veerasana (warrior's pose), Triyak Tadasana (triangular palm tree pose), Dolasana (swinging pose), Dwikonasana (double angle pose), Vrukshasana (tree pose) Supine: Merudandasana (spinal column pose), Uttan Padasana (raised foot pose), Shavasana (corpse pose), Pavanmuktasana (wind releasing pose), Setubandhasana (bridge pose) Matsyasana (fish pose), Kadharasana (shoulder pose) Sitting: Vajrasana (thunderbolt pose), Sukhasana (Easy pose), Marjariasana (cat stretch pose), Janu Sirshasana (Head to knee pose), Veerasana (hero's pose), Ardhpadasana (half Lotus pose) Prone: Ardh Dhanurasana (half bow pose), Bhujangasana (cobra pose), Ardh Shalabasana (half locust pose), Makarasana (crocodile pose), Dhanurasana (bow pose), Supta Sahajanasana (sleeping pose) Pranayama: Kapalhati (basic) (frontal brain cleansing breath), Nadi Shodhana (psychic passage purification), Bhastrika (bellow's breath), Morchana (fainting breathing), Bhramara (humming bee), Samaveta (together breathing) (Table: Detailed list of Asana)	Not reported	A licensed practitioner with a master qualification in yoga	Badsha et al 2009 (Q1) ⁸³

Table 5a. Risk of Bias (ROB) Assessment of the Included Randomized Clinical Trials

Table 5a	Risk of Bias (ROB) assessment of the included randomized clinical trials							
References	Experimental	Comparator	D1	D2	D3	D4	D5	Overall
Kiran et al. 2014	Raiyoga	Passive	+	!	+	+	!	!
Bathia et al 2007	Yoga	Active and Passive	+	!	+	+	-	!
John et al.2007	Pranayama Kiria	Passive	+	-	+	+	!	-
Ulug et al. 2018	Iyengar Yoga	Active	+	!	+	+	-	!
Dunleavy et al. 2016	Hatha Yoga	Active and Passive	+	+	+	!	+	!
Cramer et al. 2013	Iyengar Yoga	Active and Passive	+	+	+	!	+	!
Michaelsen et al. 2012	Iyengar Yoga	Passive	+	+	+	+	+	+
Pitchai et al. 2020	Yoga	Active	+	!	+	+	!	!
Jain et al. 2019	Yoga	Active	+	+	+	!	+	!
Bucht et al. 2019	Sauna Yoga	Passive	+	!	+	!	-	!
Eyigor et al. 2017	Yoga	Active and Passive	+	+	+	!	!	!
Loudon et al. 2016	Satyanda Yoga	Passive	+	!	+	+	!	!
Sardesai et al. 2020	Shavasana	Active	+	+	+	-	!	-
Garfinkel et al. 1998	Hatha Yoga	Active	+	+	+	+	+	+
Lai et al. 2023	Hatha Yoga	passive	+	+	+	+	!	!
Rathod et al. 2016	Hatha Yoga	Passive	+	+	+	+	!	!
Dash & Telles 2001	Yoga	Active	+	+	+	-	-	-
Dash & Telles 1999	Yoga	Active	+	!	+	-	!	-
Puksic et al. 2021	Yoga	Passive	+	+	+	!	+	!
Gautam et al. 2020	Ashtanga Yoga	Active	+	+	+	+	-	!
Ganesan et al. 2020	Yoga	Active	+	+	+	+	!	!
Ward et al. 2017	Yoga	Active	+	+	+	!	!	!
Evans et al. 2013	Iyengar Yoga	passive	+	+	+	!	+	!
Badsha et al. 2009	Raja Yoga	Active	+	!	+	+	-	-
Yildirim et al. 2022	Hatha Yoga	Passive	+	!	+	+	!	!
Monro et al. 2018	Yoga Nidra	Passive	+	+	+	!	+	!
Poojari et al. 2023	Yoga	Passive	+	!	+	!	+	!
Roséen et al. 2023	Hatha Yoga	Passive	+	+	+	+	+	+
De Giorgio et al. 2023	Hatha Yoga	Active	+	+	+	+	+	+
Adhikari et al. 2022	Several Yoga styles	Passive	+	+	+	+	!	!
Arya et al. 2022	Yoga	passive	+	+	+	+	!	!
Segun Fowler et al. 2020	NA	Passive	+	!	+	!	+	!
Neyaz et al. 2019	Hatha Yoga	Active	+	+	+	!	+	!
Hartfield et al. 2017	Hatha yoga	passive	+	!	+	+	!	!
Tekur et al.2014	Yoga	Active	+	+	+	!	-	!
Shermann et al. 2009	Vinyoga	Active and Passive	+	+	+	+	+	+
Williams et al. 2005	Iyengar Yoga	Active	+	+	+	+	+	+
Luo et al. 2023	Hatha Yoga	Active	+	-	+	-	+	-
Cheung et al. 2014	Hatha Yoga	Passive	+	+	+	+	!	!
Park et al. 2020	Yoga	Passive	+	!	+	+	!	!
Moonaz et al. 2015	Hatha Yoga	Passive	+	+	+	+	!	!
Bennel et al. 2022	Hatha Yoga	Passive	+	+	+	+	!	!
Gasemi et al. 2012	Hatha Yoga	Passive	+	!	+	!	-	-

D1 = Randomisation process; D2 = Deviations from the intended intervention; D3 = Missing outcome data; D4 = Measurement of the outcome; D5 = Selection of the reported result.

Green Circle = low risk of bias; Yellow Circle = some concerns; Red Circle = High risk of bias.

Table 5b. Newcastle - Ottawa Quality Assessment Scale of the Included Prospective Studies

Study	Selection				Comparability	Outcome			Quality assessment ^a	
	D1	D2	D3	D4	D1	D1	D2	D3	Total	
Kim et al 2017	*		*	*	*	*	*		6	Moderate
Ha et al 2015	*	*	*	*	*	*	*		7	High
Sohrabi et al 2020	*		*	*	*	*	*		6	Moderate
Manik et al 2017	*		*	*	*	*			5	Moderate
Di Benedetto et al 2005	*		*	*	*	*	*		6	Moderate
Nair et al 2022	*			*		*			3	Low

Selection: D1 = Representativeness of exposed cohort; D2 = Selection of non-exposed cohort; D3 = Ascertainment of exposure; D4 = Demonstration that outcome was not present at start.

Comparability: D1 = Comparability based on design or analysis (confounder control).

Outcome: D1 = Assessment of outcome; D2 = Duration of follow-up; D3 = Adequacy of follow-up.

^aQuality assessment scoring: 0-3: Low Quality; 4-6: Moderate Quality; 7-9: High Quality.

pharmacological-treated controls. Better improvements than educational group⁷⁸ or no intervention.⁸²

Methodological Quality Assessment of Included Studies

Among the included RCTs, the greatest variability in risk of bias was observed in D4 (blinding of outcome assessment) (Table 5a). Blinding of participants and personnel was generally not feasible given the visible difference between yoga and non-yoga interventions. However, this limitation unlikely introduced performance bias, as the assessed outcomes were not influenced by participants' awareness of group allocation. Selection of the reported result (D5) remains a critical concern, since many studies did not have a pre-specified trial registry or a feasibility study.

In contrast, D1 (random sequence generation) consistently rated in most of the study as low risk. It should be noted that D2 (allocation concealment) was often underreported. Concerning missing outcome data (D3), very low drop rate was observed in most of the studies. The full evaluation data are reported in research data section (Table S3 of Supplementary materials).

Six prospective clinical studies were assessed using NOS (Table 5b). One study was rated as high quality (7 points).⁵⁰ Four studies were rated as moderate quality, with scores ranging from 5 to 6.^{45,54,61,72} One study was rated as low quality (3 points), due to incomplete reporting in both selection and outcome domains.⁷⁶ The most affected domains were the absence of a control group and the absence/lack of long-term follow-ups.

Discussion

This review examined the clinical effects of yoga interventions for MSDs and pain in prospective and randomized clinical studies. The analysis focused on specific factors such as specified musculoskeletal diseases and pain conditions,

details of yoga protocols, and reported benefits including both measured parameters and self-reported outcomes (e.g., pain, disability, mobility test, quality of life). The summary of the clinical results/outcomes emphasized an updated effectiveness of yoga interventions for musculoskeletal disorders and pain.

Yoga comprises the physical practice of yoga (asana) and relates to the body. Asana practice focuses on the physical aspect of yoga, consisting of performing yogic postures related to awareness, concentration, control, balance, flexibility and endurance. Yoga asana involve deep/intense postures and movements and myofascial stretching in which the entire muscle-tendon system included myofascia subcategories (perimysium, epimysium and endomysium) are stimulated.

These postures of deep stretching exert a renewal action by a squeezing effect⁸⁶ with circulation and renewal of biological fluids, dehydration-rehydration alternance, removal of catabolites and supply of nutrients and growth factors, towards "sponge-like" connective tissues (muscles, tendons, ligaments and fascia). The biological effect on tissues depends on the accuracy, intensity, frequency and duration of asana practice and on histological characteristics related to age, sedentary/active lifestyle and dietary habits.^{72,87-89}

This review showed that yoga appears to be effective to reduce musculoskeletal symptoms and pain. The biological rationale of yoga effectiveness is related to the physiological recovery of joint mobility and intra-articular spaces, and the softening and lengthening of stiff and retracted muscle-tendon-ligamentous structures.⁹⁰⁻⁹³ This is likely a feasible explanation for every musculoskeletal area. Then, effective yoga protocols involving specific movements and exercises targeted to progressive stretching and strengthening in selected body areas^{94,95} and achievement of maximum biomechanical range of motion useful to reverse or reduce states of pain and/or reduced mobility.

Emblematic principles of yoga as conservative therapy for the treatment for musculoskeletal pain and disabilities^{94,95} involve several aspects:

- i. the recovery of mobility in all spatial directions and restoration of intra-articular spaces;
- ii. the reestablishment of spinal lordosis and the reduction of intervertebral pressure on the discs for neck and back pain;
- iii. the downgrading of intra-acetabulum pressure and the reduction of traction and compression forces towards the acetabular labrum together with the recuperation of lumbopelvic rhythm and pelvic tilt by improvement of nutation and counternutation movements, spinal lordosis for hip pain;
- iv. the recovery of shoulder joint and scapula mobility, the downgrading of intra-glenohumeral pressure at shoulder joint and the reduction of traction and compression forces towards the acromion or glenoid cavity for shoulder pain.

Yoga may also influence the main factors that maintain chronic musculoskeletal pain, such as increased pain sensitivity (inflammation and central sensitization),^{79,80,96} negative emotions (depression, anxiety, stress), fear of movement (kinesiophobia),⁶⁵ and low confidence in managing pain (confidence in self-efficacy). Yoga combines gentle and progressive movements, controlled breathing, and mindful attention, which can help calm the nervous system, reduce stress, and improve pain tolerance.⁹⁴ Some studies have shown that yoga can lower pain-related fear and negative thoughts, improve mood, and increase confidence in daily activities.^{32,34-36}

We elaborated the following consecutive cause-effect and/or intercorrelated events in MSDs affected area. Disuse, and lack of movement reduce blood afflux & circulation, with low nourishment/nutrients supply, O₂ deficiency & increased CO₂ (local acidosis) and catabolites. Prolonged disuse for kinesiophobia reduces mobility and causes tissue contraction and stiffening with consequent joint compression, reduced joint range of motion, growing disability and decreasing day life autonomy.^{94,95}

We highlight that asana involves deep movements and represents the key to induce biological changes (both histological and anatomical) with following effects on the histological tissues (muscles, tendons, ligaments and fascia) and restoring physiological kinesiology (the range of movement spontaneously increase in intensity with practice - allow a gradual and delicate self-rehabilitation).

We underline that in tissues subjected to stretching, a significant regulation of oxidative stress and expression of pro- and anti-inflammatory genes and mediators occurs, a remodeling of the extracellular matrix expressed by changes in collagen and matrix metalloproteinases levels, an increase of microvascular volume, number of capillaries per muscle fiber, levels of hypoxia-inducible factor 1, vascular endothelial growth factor and nitric oxide synthetase.

Stretching and relaxation exercises such as yoga lower stress levels, enhance the immune response, reduce circulating IL-6, and increase anti-inflammatory IL-10 levels.⁹⁶

These effects, together with its physical benefits, help explain why yoga is effective across different musculoskeletal conditions, even when compared with active treatments such as exercise or physiotherapy.

The authors of this review wish to emphasize the importance of the protocol details for the relevance of a study. Some studies included in this review underestimated the importance to show asana images or to describe unequivocally and in detail each posture inserted in the protocol, preferably also including the Sanskrit name. It was unexpected that even when designed by yoga experts, in some studies protocols were not detailed or imprecise, likely because they are not scientists or researchers, bringing out the need to have authors who are both practitioners and researchers (academic research scientists). It is highly recommended for future studies to adopt a minimum standard checklist yoga-specific extension reporting detailed lists of asanas with their names, repetitions, duration, sequencing, as well as breathing and relaxation components (e.g., our proposed parameters template tables). In addition, most of the discussions in the analysed papers are short or very short and just compare the obtained clinical outcomes with the results of previous studies. Many of the analyzed studies do not include comments on the physiological response or biological events related with yoga practice that could have supported and allowed to identify the physiological mechanisms and interpret the clinical outcomes and the rationale of yoga interventions.

In this review, the analysis of the yoga protocols has been challenging as looking for analogies of asana and for the comparability of protocols in terms of frequency and total duration. Asana and yoga techniques reported in the selected studies were often indicated with different (uncommon) names or imprecise description. Then, a great effort was made to identify equal or similar asana in the various protocols. The detail of the Sanskrit asana name or its English translation/description is important for the precise/unequivocal identification of a posture. We explored all protocols to identify same movements or asana reported with different names. Then, for clinicians practical use, we summarize below yoga exercises specifically targeted for body areas and related pathologies. There are different parameters to take into consideration in order to analyze and interpret the effects of yoga asana over time. Specifically, asana practice with equal total minutes of execution is not the same when the practice is short and frequent or long and deferred over time. In addition, also the accuracy and intensity of asana execution (the movement should be gently and gradually forced) have a great effect on clinical results and benefits for MSDs.

Yoga For Headache and Neck Pain

This review highlights that yoga for headache and neck pain supplied more improvements of both measurable outcomes

and self-reported improvements than drugs or self-care of control group. Yoga showed benefits in both tension headache and migraine as both neck-related headaches.^{84,85}

Neck pain is a prevalent neurologic and musculoskeletal complaint in the general population and is often associated with primary headache disorders such as migraine and tension-type headache. A high rate, ranging from 73% to 90%, of people with migraine or tension-type headache have coexisting neck pain, and there is a positive correlation between headache frequency and neck pain. Furthermore, neck pain has been identified as a significant risk factor for migraine and tension-type headache.^{84,85}

Comments or speculations on the biological effect of yoga on pathophysiological mechanisms have been expressed just in 3 studies^{40,41,47} suggesting that yoga may alleviate symptoms and pain, and modulate stress responses through integrated physiological mechanisms as modulation of autonomic and neuroendocrine response, neck spine mobilization and decompression, release of neck muscles.^{40,41,47,84}

Cramer et al suggested that yoga postures can be seen as a form of isometric muscle training, involving prolonged static muscle contractions and increasing cervical proprioceptive acuity.⁴⁷ Yoga also was able to increase awareness of muscle tonus and joint position and is also thought to help in recognizing and changing habitual patterns of posture and muscle tension in daily life.⁴²

John et al proposed that yogic breathing modulates autonomic and neuroendocrine responses and calming the stress response contributing to a state of calm alertness through the enhancement of parasympathetic drive.⁴⁰

Kumar et al suggested that the mechanism of reducing headaches symptoms of yoga postures is related to the increase of vasovagal tone, to the shift on a parasympathetic drive and the potential increase of nitric oxide levels, an endothelium-derived relaxing factor-like substance.⁴¹

We want to draw attention that nowadays lifestyle never requires looking upwards and not even to extend your neck, and intense rotation is rarely necessary. Therefore, yoga protocols for neck disorders involve mainly asana in extension and passive flexion to release the stiff (and painful) posterior neck and nuchal muscles, to mobilize and decompress spine discs.⁹³ As further support, a recent study clearly demonstrated that ergonomic interventions (specifically neck and core combined stabilization practices) improved pain, disability and strength in patients with chronic non-specific neck pain.⁹⁷

Yoga practices in various protocols for head and neck have been interpreted (to overcome the inhomogeneous names and definitions) and condensed in Table S2 specifically elaborated for clinicians to simplify/facilitate and encourage their use. Asana for cervical flexion and extension (forward, lateral and right/left) and rotation (right/left) have been then highlighted: -Asana involving active or passive neck extension (in some associated back extension) reported in many protocols are Bhujangasana, Ustrasana, Ardha Chakrasana, Dhanurasana,

Matsyasana, Salabhasana. -Asana requiring passive neck flexion were in protocols including forward flexions of the trunk as Adho Mukha Svanasana, Padahasthasana or Paschimottanasana or Uttanasana, or Shashankasana (or Balasana or Apanasana), Setu Bandhasana (or Sarvangasana or Viparita Karani). -Asana with neck rotation were present in many protocols, such as Trikonasana (or Parsvakonasana), Vakrasana, Bharadvajasana, Virabhadrasana II, and Ardha Matsyendrasana. -Generic neck rolls (Greeva Sanchalana) and flexion/extension are reported in 2 studies. -Just 1 protocol included Suryanamaskar and 2 protocols enclosed Pavanmuktasana.

Yoga For Shoulder and Wrist-Hand Pain, and For Upper Crossed Syndrome

This review suggests yoga for shoulder and wrist-hand musculoskeletal-related pain provides greater benefits of both measurable outcomes and self-reported pain conventional stretching, exercises, rehabilitation or even NSAIDs.

Interestingly in frozen shoulder, yoga asana significantly improved shoulder abduction, shoulder flexion, and shoulder internal rotation compared with physiotherapy control group,⁴⁸ and similar valuable improvement of yoga in self-reported pain and disability scores compared to the control group receiving NSAIDs and physical therapy.⁴⁹

For shoulder pain, sauna yoga significantly improved balance abilities and self-reported quality of life (but no significant improvements of lateral flexibility of the spine, shoulder flexibility, strength in lower extremities as we can expect following a low number of asana and intensity of practice),⁵⁰ and also yoga induced significant improvements in self-reported pain in shoulder and arm.⁵¹ Satyananda yoga significantly reduced pelvic obliquity and improved lumbo-pelvic posture, and increased strength in shoulder abduction in both affected and non-affected arms.⁵¹ Hatha yoga exercise markedly affected plasma biomarkers, with a significant decrease of malondialdehyde reflecting reduction of oxidative stress and a significant increase of superoxide-dismutase antioxidant enzyme activity.⁵²

Iyengar yoga intervention for upper crossed syndrome led to a significant increase in the cervical and shoulder angles, and a significant decrease in thoracic flexion angle.⁵⁴

Hatha yoga for carpal tunnel syndrome induced self-reported pain reduction, improvement in grip strength, and in Phalen sign (Wrist Flexion Test); no differences were reported in self-reported sleep disturbance, Tinel sign, sensory and motor nerve conduction time compared with wrist splint in controls.⁵⁵

Interestingly, it has been speculated that the effectiveness of joint mobilization in individuals with carpometacarpal joint osteoarthritis may exert its effects through a neurophysiological rather than a biomechanical response, and also suggested that supraspinal pain-inhibitory areas, including the periaqueductal gray matter, can be stimulated by joint mobilization.⁹⁸

In handgrip strength in patients with stroke, hatha yoga decreased significantly the systolic blood pressure, while the diastolic blood pressure decreased but not significantly. Hand grip strength improved significantly in both unaffected and affected hands. The control group showed no significant change in systolic or diastolic pressure, and no significant change in grip strength for both hands.⁵⁶ Yoga induced a significant increase in pulse rate and blood pressure following the handgrip test,⁵⁷ a significant increase in hand grip strength and hand grip endurance compared with control,⁵⁸ and a significant increase in motor speed in repetitive finger movements of patients with hand rheumatoid arthritis.⁵⁹

Varied shoulder joint and arm(s) movements are omnipresent movements in yoga protocols, namely vertical flexion or hyperflexion, vertical hyperabduction, extension or hyperextension with external rotation or medial rotation, horizontal and inferior abduction (in standing, sitting, kneeling or supine position).

Yoga practices and joint movements in various protocols for shoulders and wrist-hand pain, and for upper crossed syndrome have been interpreted (to overcome the inhomogeneous names and definitions) and condensed in [Table S2](#) specifically elaborated for clinicians to enable their use. Yoga interventions involve: -Vertical flexion or hyperflexion of the shoulder w/wo external rotation or medial rotation is involved in Urdhva Hastasana, Ardha Chakrasana, Virabhadrasana I, Utkatasana, Vrksasana, Adho Mukha Svanasana, Parivrtta Parsvakonasana, Astha Chandrasana, Anjaneyasana, Dandayamna Bharmanasana, Shashankasana, Darmikasana, Adho Mukha Svastikasana, Gomukhasana (Gomukhasana involving the complex and compound movement of external rotation & abduction (for upwards arm) + internal rotation and adduction (for downward arm). -Extension or hyperextension with abduction or adduction and external rotation or medial rotation is performed in Dwikonasana, Purvottanasana, Setu Bandha Sarvangasana, Viparita Karani, Halasana, Marichyasana, yoga Mudrasana, Matsyasana, Salabhasana. -Abduction, Hyperabduction, horizontal and inferior abduction is practiced in Tadasana, Tiryaka Tadasana, Ardha Kati Chakrasana, Kati Chakrasana, Garudasana, Virabhadrasana II, Parivrtta Trikonasana, Vasisthasana, Supta Matsyendrasana, Parivrtta Pashimottanasana. -Circumduction is carried out in Skandha Chakra. -Generic neck rolls (Greeva Sanchalana) and shoulder circles (Skandha Chakra) are reported in 3 studies.

Shoulder pain and disabilities are mainly related to joint compression, reduced mobility, and impingement. Joint compression may arise from retracted or stiffened musculotendinous unit-ligament complex. Key points of yoga treatment for shoulder pain are asana involving glenohumeral joint mobility, and their practice with intense movement.⁹⁰ In yoga asana, movements and postures involving arms flexion and extension - which spontaneously increase in intensity with practice - allow a gradual and delicate self-rehabilitation. Shoulder extension movements such as (hyper)extension

with abduction and external rotation or with adduction and medial rotation (as in Gomukhasana, Parsvottanasana, Kati Chakrasana, but also Garudasana and Purvottanasana) appear to create the greatest benefit. Yoga asana create joint distraction that enlarge/increase glenohumeral joint space, and stretches and softens the musculo-tendinous-ligament system.

Yoga For Spine, Hip and Leg-Knee Disorders and Pain

Yoga For Disc Herniation. Yoga intervention has been successfully used for neuropathic pain due to lumbar disc herniation related to nociceptive sprouting within a degenerated disc, to mechanical compression of the nerve root, and to the inflammatory mediators arising from the degenerating disc.⁶⁰ The repetition of stretching and strengthening poses in yogasana, involving lumbar spine range of motion exercises together with neural mobilization (neural tensioning technique) and stabilization exercises to protect the spine explain the achieved significant improvements in clinical outcomes of yoga group.⁶⁰ The authors believe that mobilization and tensioning may improve patient symptoms, such as hyperalgesia and allodynia, resulting in overcoming the pathogenic pathway of neuropathic pain and disability.⁶⁰ Among the multifactorial origins of yoga improvements should be included the decreased allodynia and hyperalgesia induced by the increase of anti-inflammatory cytokines, and the healing or regeneration of intervertebral disc mechanical compression imparted by the applied forces/stress and loading pattern during yogasana. It is also believed that molecular and cellular changes in dorsal root ganglion sensory neurons can be induced by exercise.⁶⁰

An interesting retrospective clinical study supports these affirmations.²⁹ Yoga practitioners showed significantly less degenerative disease at disc levels C3/C4, L2/L3 and L3/L4 assessed by magnetic resonance imaging than the control group. The assumed biological mechanisms responsible for the clinical improvements have been discussed, speculating that the various positions held by the spine during the yoga sessions retard disc degeneration by increasing the ability of nutrients to diffuse into the disc, and also that disc compression and tension during yoga exercises can stimulate the synthesis of growth factors by the fibrocytes and chondrocytes residing in the disc.²⁹

Yoga For Chronic Back Disorders and Pain. This review highlights that yoga for chronic back pain provides greater benefits of both measurable outcomes (as inflammatory cytokines, beta-endorphins, disability, nociceptive reflex, spinal mobility) and self-reported pain, stress, disability, kinesiophobia, emotion regulation, energy, quality of life than conventional educational strategies. Significant changes in biomarkers related to pain transmission and intensity, like salivary CGRP (Calcitonin Gene-Related Peptide), TNF- α and β -endorphin together with reduction of pain intensity and

type, pain catastrophizing scale, fear of movement, functional ability and quality of life in patients with low back pain after 1 and 3 months of yoga intervention.⁶¹

Of great scientific and clinical relevance is the demonstration of the epigenetic effect of yogasana reported by Adhikari et al 2022.⁶⁶ They suggest a mechanism of action of yoga on pain by inducing self-efficacy and emotion regulation, pain severity changes and neurophysiological changes as well as through changes in gene expression and DNA methylation profiles.⁶⁶ The analysis of differential expression genes from pre- to post-intervention identified a unique transcriptional response to yoga. Yoga intervention induced increased expression of antisense genes, some of which are pain involved genes, and these participants reported a greater reduction in pain following the 12-week yoga intervention. In addition, it has been demonstrated the 33 differentially hypomethylated positions after yoga with implication of genes involved in NIK/NF- κ B signaling, a major pathway that modulates immune function and inflammation.⁶⁶

Frequent causes of low back pain are related to psoas muscle shortening and loss of lumbar lordosis due to the sedentary lifestyle and shortening/retraction of the knee flexor muscles, mainly hamstrings due to prolonged sitting.⁹⁵ Therefore, pivotal/pillar movements for back pain are asana in extension (frequently in the form of backbends).

Yoga practices in various protocols for spine and chronic low back pain have been interpreted (to overcome the inhomogeneous names and definitions) and condensed in [Table S2](#) specifically elaborated for clinicians to enable their use. Yoga interventions involve:-Asana in extension included in many protocols are Dhanurasana, Bhujangasana, Ardha Urdhva Dhanurasana, Bitilasana, Urdhva Mukha Svanasana, Setu Bandha Sarvangasana, and Ardha Chakrasana. This increase and improve the lordosis of the lumbar spine. Matsyasana and Salabhasana involve the extension of the entire lumbar-thoracic-cervical spine.-Asana in flexion are key movements to elongate and release the back muscles, mainly erector spinae and quadratus lumborum. Many protocols included Uttanasana, Padangustasana, Padottanasana, Balasana, Adho Mukha Virasana, Apanasana, Halasana, Jhulana Lurhakanasana, and Pawanmuktasana.-Twisting and side bendings are essential movements to release the deepest back muscles, namely intervertebral muscles including interspinales and transversospinales (intertransversarii, multifidus, rotatores) but also semispinalis (capitis, cervicis, thoracis), longissimus, iliocostalis and multifidus. Asana present in the protocols achieved this were Marichyasana (and its variants), Ardha Matsyendrasana, Vakrasana, Bharadvajasana, Kati Chakrasana, Ardha Kati Chakrasana and Parsva Urdhva Hastasana and Ardha Chandrasana and Shithilikarana Vyayama, Tiryaka Tadasana, Parivrtta Trikonasana, Parivrtta Utkatasana, Parivrtta Parsvakonasana and Parivrtta Baddha Parsvakonasana, Parivrtta Anjaneyasana, Parighasana, Parivrtta Pashimottanasana, Parivrtta Janu Sirsasana, Bananasana, Supta Matsyendrasana, Jathara Parivartanasana, Markatasana, Supta Udarakarshanasana, and Shava Udarakarshanasana.

Yoga For Hip and Leg-Knee Disorders and Pain. This review emphasizes that yoga for hip disorders supplied more improvements of measurable outcomes (e.g., mobility tests, osteoarthritis index, stiffness, physical performance, pelvic tilt) and self-reported pain compared to education or no intervention.

Changes in hip extension and anterior pelvic tilt demonstrated strong and linear dose-response associations with both duration and frequency of yoga practice, suggesting a direct, causal relationship between yoga intervention and postural and biomechanical changes.⁷² Yoga therapy helps to improve tone of the muscles around joints and, therefore, improved flexibility, and hence in the present study, showed the improvements in pain and function. The increase in muscle flexibility and strength decrease the level of pain and improve the function.⁷⁶ Gradual slow and prolonged lengthening is preferable to minimize activation of stretch reflex and subsequent increase in muscle tension and reflexive resistance to muscle elongation during stretching. The lack of wide hip movements related to lifestyle (prolonged sitting or standing) leads to stiffening and retraction of musculoskeletal structures involved in hip mobility and stability, increase the acetabular tear consisting in excessive contact stress/force of the femur-head against acetabular fossa and/or labrum hip impingement). Yoga protocols for hip joint⁹⁵ involve asana to regain/restore the physiological kinesiology by improving tissues extensibility, reducing connective tissues tightness and retractions, decreasing the excessive acetabular tear (femur-head towards acetabulum) at the hip joint and restoring the acetabulum-femoral head space.

Hip joint muscles pulling the femur towards the acetabulum (or labrum) by bone-to-bone traction force generate femur-head to acetabular fossa compression/crushing forces. Gluteus minimus, gluteus medius, pectineus pull obliquely upwards and medially; sartorius, tensor fasciae latae, biceps femoris, gracilis, adductors and iliopsoas pull upwards; piriformis pulls obliquely medially and (slightly) upwards; quadratus femoris pulls medially; gemelli and obturators pull obliquely medially and (slightly) downwards. In yoga protocols analyzed in this review, full movements involving leg(s) and hip joint are omnipresent in standing, sitting, kneeling or supine asana. Yoga positions include flexion, vertical abduction, horizontal and inferior abduction and adduction, extension, maximized whenever possible (hyperflexion with posterior glide of the femur head, hyperabduction, hyperadduction, hyperextension with anterior glide), with external/lateral rotation or internal/medial rotation.

Yoga practices in various protocols for hip and leg have been interpreted (to overcome the inhomogeneous names and definitions) and condensed in [Table S2](#) specifically elaborated for clinicians to simplify/facilitate and encourage their use. Yoga interventions involve:-Femur head distraction is present in most of

the protocols to reduce the intra-articular pressure exerted by the femur head on the acetabulum. Hip distraction is obtained by compound hip movement flexion+abduction+external rotation with the knee flexed, as in Gomukhasana, Garudasana, Supta Matsyendrasana, Ardha Matsyendrasana, Ardha Padmasana; hip distraction in association with posterior glide of femur head is achieved in Eka Pada Rajakapotasana, Adho Mukha Svastikasana, Parivrtta Utkatasana, Parivrtta Baddha Parsvakonasana, Parivrtta Baddha Parsvakonasana and Parivrtta Trikonasana. -Posterior glide of the femur head is obtained in Marichyasana, Uttanasana, Ardha Uttanasana, Aschwa Sanchalanasana, Balasana, Darmikasana, Adho Mukha Virasana, Shashankasana, Apanasana, Janu Sirsasana, Padangustasana, Pada Hastasana, and Supta Padangustasana. -Anterior glide of the femur head is achieved in Purvottanasana, Setu Bandha Sarvangasana, Ardha Chakrasana, Virabhadrasana I, Anjaneyasana, Astha Chandrasana or Alanasana, Dhanurasana, Urdhva Dhanurasana, Ardha Urdhva Dhanurasana, and Ustrasana. -Asana with rotation in one or both hip joints are performed in Eka Pada Rajakapotasana, Garudasana, Ardha Matsyendrasana, Supta Matsyendrasana, Bharadvajasana, Parivrtta Trikonasana, Parivrtta Parsvakonasana, Gomukhasana, Sukhasana. These asanas are very intense and powerful in removing joint compression and in reducing muscle retraction and stiffening. -Asana involving hip flexion or hyperflexion w/wo external rotation or medial rotation are Urdhva Hastasana, Ardha Chakrasana, Virabhadrasana I, Utkatasana, Vrksasana, Adho Mukha Svanasana, Parivrtta Parsvakonasana, Astha Chandrasana, Anjaneyasana, Dandayamna Bharmanasana, Shashankasana, Darmikasana, Adho Mukha Svastikasana, and Gomukhasana; -Asana with hip extension or hyperextension with abduction or adduction and external rotation or medial rotation are performed in Dwikonasana, Purvottanasana, Setu Bandha Sarvangasana, Viparita Karani, Halasana, Marichyasana, Yoga Mudrasana, Matsyasana, Salabhasana; -Asana with hip abduction or hyperabduction are practiced in Tadasana, Tiryaka Tadasana, Ardha Kati Chakrasana, Kati Chakrasana, Garudasana, Virabhadrasana II, Parivrtta Trikonasana, Vasisthasana, Supta Matsyendrasana, Parivrtta Pashimottanasana.

Yoga For Generalized Arthritis

This review emphasizes that yoga for arthritis provides better improvements of both measurable outcomes (e.g., inflammatory markers, pain disability, swelling) and self-reported pain, mood, disability compared to antirheumatic drugs and DMARDs.

Comments or speculations on the biological effect of yoga on pathophysiological mechanisms have been expressed in only 2 studies that highlighted yoga's potential role in modulating autonomic function, reducing inflammation, and improving overall physiological and psychological balance.^{79,80} Ganesan's study found that the decrease of sympathetic activity provided by yoga postures lead to reduced secretion of inflammatory markers IL-1, IL-6, and TNF-alpha as well as cortisol levels.⁷⁹ Gautam reported that yoga

postures influenced the release of pro-inflammatory cytokines (decreased TNF-alpha, TGF-beta, IL-6) and downregulated T cell receptor signaling and pathways (NFKB, RELA, TNFR2). Moreover, yoga therapy modulated the vagus nerve activity and increased mind-body communicative markers (beta endorphin, sirtuin).⁸⁰

Yoga practices in various protocols for arthritis have been interpreted (to overcome the inhomogeneous names and definitions) and condensed in [Table S2](#) specifically elaborated for clinicians to simplify/facilitate and encourage their use. Yoga interventions involve:-Asana with spine extension such as Bhujangasana and/or Dhanurasana, Marjariasana, Matsyasana and asana involving strengthening with spine extension such as Setu Bandhasana and/or Viparita Karani, Salabhasana, and Matsyasana. -Asana with hip abduction with external rotation (and knee flexion) as Konasana (4/6) and its Konasana variations, Sukhasana (easy crossed-legs pose), Ardha Padmasana (half lotus), Vrksasana (Tree pose), Ardha Bhekasana (half frog), Janu Sirsasana; -Asana involving knee flexion as Vajrasana (Thunderbolt pose) or knee flexion with abduction such as Veerasana and Virasana (Hero Pose) or hip adduction and distraction such as Gomukhasana; -Side bending or twisting movements such as Trikonasana, Ardha Chandrasana, Tiryaka Tadasana, Katichakrasana, seated twist, and Bharadvajasana.

Methodological Considerations

We would summarize final considerations on the methodological variability and limitations. While the overall findings suggest that yoga interventions provide measurable benefits for musculoskeletal disorders and pain, the considerable variability in study design and results presentation represent an important limit for generalized conclusions.

It was not possible to perform a formal meta-analysis primarily due to the substantial methodological heterogeneity across the included studies, which limited the feasibility of pooling data in a statistically meaningful way and reducing the reliability of aggregated effect estimates.

There was wide variability in sample size (20-250 participants) and age (18-75 years, mostly middle-aged or older adults). Sample size calculation was absent in 16 studies and inadequate in 6, limiting the generalizability of findings. Reported asana names were inconsistent across studies, making it difficult to consolidate the most used protocols for each body area.

Control groups varied considerably, including passive comparators (e.g., waitlist, no intervention) and active ones (e.g., stretching, Pilates, physiotherapy, NSAIDs, DMARDs). For neck and shoulder pain, active comparators were more frequent, potentially attenuating the relative benefits of yoga.

Outcome measures were heterogeneous, with both objective assessments (e.g., muscle thickness, range of motion, oxidative stress biomarkers, electromyography) and self-reported measures (e.g., pain, disability, quality of life). Standardized scales such as the Visual Analog

Scale (VAS), Neck Disability Index (NDI), Oswestry Disability Index (ODI), Western Ontario and McMaster Universities Arthritis Index (WOMAC), and SF-36/WHOQOL were used in some studies, while others relied on non-standard tools, limiting cross-study comparability and reproducibility. In some cases, improvements reached clinically important significance.

Long-term effects remain uncertain due to the scarcity of follow-up data. Potential confounders (such as yoga instructor expertise, participant adherence, and concurrent medical treatments) may have influenced outcomes. Some minor, self-resolving complications were reported, and limited major adverse events occurred.

This review is the first to comprehensively analyse these methodological aspects and highlights that variability in control groups, outcome measures, and protocol reporting affects the clinical relevance and comparability of results.

To strengthen future trials on yoga for musculoskeletal disorders, researchers should ensure adequate sample sizes with power calculations, select appropriate control groups, and conduct long-term follow-ups. Clear reporting of participant selection, adherence, and detailed yoga protocols (including specific asana and session structure) is important to ensure reproducibility and to allow comparative analyses.

Conclusions

This review of the updated literature on yoga interventions for musculoskeletal disorders (MSDs) showed significant benefits. The data from the included studies is extensive, covering a broad range of clinical outcomes. Both objective measures (e.g., mobility, biomarkers) and subjective outcomes (e.g., pain, disability, quality of life) were generally improved in the yoga groups compared to controls, and in some studies, yoga even outperformed pharmacological treatments. Our narrative synthesis allowed us to create a summary of yoga asana and related clinical evidence. The variability of yoga styles (e.g., Iyengar, Hatha) and the numerous postures may increase the risk of confounding the specific contributions of individual asana and other yoga components. Our analytical approach allowed us to elaborate a summary of yoga techniques and related clinical evidence. The different type of yoga (as Iyengar, Hatha) and the hundreds of yoga postures may increase the risk to confound the role and effect of the yogic approach.

The present review outlines the potential effectiveness of yoga in several body areas affected by MSDs, enhancing mobility, reducing drug dependence, and improving quality of life.

In particular the review based on multiple randomized studies showed significant benefits of yoga although heterogeneity in protocols limits reproducibility, namely:

1. a significant effect to improve MSD symptoms (6/8 studies) for head and neck pain,

2. a significant positive evidence (8/13 studies) of reduced pain and disability for shoulder and hand disorders,
3. evidence of symptom relief and improved mobility for back pain, hip, and knee disorders, though some minor adverse events were reported (16/22 studies),
4. a significant positive evidence indicated pain reduction and lowering of inflammatory markers for generalized arthritis (5/6 studies).

Based on these findings, yoga might be considered as a complementary therapeutic support alongside conventional pharmacological and surgical treatments.

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Data Availability Statement

Data are derived from previously published studies that are publicly available in scientific databases. Extracted data supporting the findings of this review are available from the corresponding author upon reasonable request.

Preregistration/Protocol

This review was not preregistered, no review protocol is available.

Supplemental Material

Supplemental material for this article is available online.

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