

The role of yoga in arthritis treatment in the UK:

A critical examination of the evidence

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Abstract

Arthritis comprises a set of musculoskeletal conditions with a rising global prevalence, including in the United Kingdom (UK). It poses significant health, social, and economic burdens and negatively impacts the quality of life. Yoga, an ancient mind-body discipline from the Indian subcontinent, is gaining recognition worldwide and also in the UK. Many people practice it in various health conditions to enhance their well-being. Notably, arthritis is one of the most frequently reported health conditions by attendees in yoga sessions in the UK. However, the term "yoga" encompasses a wide range of practices and yoga interventions tend to be complex, differing in their key features, including content, structure, and delivery characteristics. Previous systematic reviews on the effectiveness of yoga for arthritis have included randomised controlled trials (RCTs) from around the world and have highlighted variations in both the definition and key features of yoga interventions. These inconsistencies make it challenging to select yoga interventions that may be the most effective in arthritis treatment. To address this gap in the UK context, this thesis aimed to conduct two separate systematic reviews to synthesise the key features of effective yoga interventions used as complementary approaches for the

treatment of osteoarthritis and rheumatoid arthritis, the two most prevalent types of arthritis in the UK. Given the limited number of UK-specific qualitative studies on barriers and facilitators to yoga practice in people with arthritis, this thesis undertook a qualitative systematic review of global evidence, including studies from the UK, with findings that can support the implementation of yoga interventions in the UK context. Additionally, due to a lack of primary qualitative studies exploring insights from yoga providers regarding arthritis treatment in the UK, a qualitative study was conducted to help guide recommendations for integrating yoga into arthritis treatment. Overall, this thesis aimed to critically examine the role of yoga as a complementary intervention for arthritis, focusing on its potential within the UK. It comprises four chapters, three global systematic reviews and a UK-based qualitative study. All systematic reviews in the thesis adhered to the JBI and Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines.

Chapter Two includes a systematic review of RCTs aimed at synthesising the key features of effective yoga interventions used as a complementary approach to osteoarthritis treatment. A search of 17 databases was conducted up to September 22, 2023, with no date and language restrictions. 18 and 16

articles (representing 16 and 14 RCTs) were included in the systematic review and meta-analysis, respectively. The included studies had low methodological quality scores, with common weaknesses such as around reporting of randomisation, allocation concealment, blinding, outcome measurement, and statistical reporting. 10 of 14 yoga interventions used in addition to pharmacological and/or non-pharmacological treatments including 1402 participants, showed significant reductions in pain (standardised mean difference (SMD) -0.70; 95% confidence interval (CI) -1.08 to -0.32) and improvements in function (-0.40; -0.75 to -0.04), compared with pharmacological (drug-based) and/or non-pharmacological treatments (conventional physiotherapy, conventional exercise, health education, wait-list or attention control, non-yogic physiotherapy, chair exercise), or no intervention. Notably, of the effective interventions, eight interventions incorporated centre-based (supervised, group) sessions, and six included additional home-based (unsupervised, individual) practice. These interventions included 34 yogic poses, eight breathing practices, and three meditation and relaxation practices, with osteoarthritis-specific pose modifications in four interventions. Eight of these effective interventions included yogic poses, and seven of them also incorporated either breathing practices, meditation and relaxation practices, or both. Centre-based

sessions typically lasted eight weeks, with 53-minute weekly sessions, while home-based sessions spanned 10 weeks, with 30-minute practice recommended four times per week. Since at least 10 studies could be included in the meta-analysis for pain and function each, a random-effects meta-regression analysis was conducted to examine whether study-level characteristics, such as session duration and intervention duration, were associated with the outcomes. Meta-regression suggested no clear statistical associations between study characteristics and outcomes, although power was limited due to the number and size of included studies.

Chapter Three includes a systematic review of RCTs that aims to synthesise the key features of effective yoga interventions in addition to standard medical treatment for rheumatoid arthritis. 17 databases were searched until November 16, 2023, without date and language restrictions. While Chapter Two did not include a Grading of Recommendations Assessment, Development, and Evaluation (GRADE) assessment, the decision to assess confidence in findings using the GRADE approach in this chapter was based on the development of my methodological knowledge and expertise over the course of this PhD. Nine articles representing five RCTs and involving 718 participants were included and had low methodological quality scores, with

similar weaknesses observed as in Chapter Two. Yoga interventions, in addition to standard medical treatment, improved disease activity scores (SMD -0.46; 95% CI -0.73 to -0.18; moderate quality evidence) and function (-0.42; -0.78 to -0.07; moderate quality evidence) but showed no significant reduction in pain (-1.06; -2.62 to 0.50; very low-quality evidence) compared to standard medical treatment alone. All five RCTs found yoga's beneficial effects on one or more outcomes. All yoga interventions included centre-based (supervised, group) sessions, and two included additional home-based (unsupervised, individual) practice. These interventions incorporated 20 yogic poses, seven breathing practices, and four meditation and relaxation practices, with two interventions offering rheumatoid arthritis-specific pose modifications. Centre-based sessions were typically delivered once a week for eight weeks, with sessions lasting around 68 minutes. Home-based yoga was recommended thrice weekly for a 10-week median duration and 40 minutes per session. Due to the limited number of studies (fewer than 10) that could be included in the meta-analysis for each outcome, meta-regression could not be conducted to examine whether study-level characteristics were associated with outcomes.

Chapter Four includes a systematic review of qualitative evidence on barriers and facilitators to yoga practice in people with arthritis. Seven databases were searched with no date and language restrictions until November 07, 2024, and nine articles, representing eight studies, were included. The studies had moderate to high methodological quality scores, with limitations primarily related to reporting the alignment with research philosophy, researcher positioning, and reflexivity. Narrative synthesis and meta-aggregation were conducted. From 112 extracted findings, 20 categories were formed, leading to five key synthesised findings: (i) Yoga, arthritis, and the body: the anticipated and experienced impacts of yoga on physical well-being influenced yoga practice; (ii) Yoga, arthritis, and the mind: levels of motivation and perceived impact on mental well- being influenced yoga practice; (iii) Yoga, arthritis, and the mind-body impact: yoga's mind-body benefits supported coping with arthritis and encouraged continued practice; (iv) Yoga, arthritis, and session accessibility and structure: factors related to session accessibility and structure influenced engagement with yoga; and (v) Yoga, arthritis, and the session environment: a supportive social environment in yoga sessions impacted yoga practice.

Chapter Five reports a qualitative study that explored UK-based yoga providers' clinical knowledge of arthritis, experiences of delivering yoga to people with arthritis, their perceived role in arthritis treatment, and perceived yoga training needs. Semi-structured interviews with 20 yoga providers were conducted, transcribed verbatim, and thematically analysed, revealing eight key themes. Yoga providers were generally aware of their attendees' health conditions and had clinical knowledge of arthritis through their yoga training. They were reasonably confident in delivering yoga to attendees with arthritis and felt that they had an important role in supporting these attendees. Gentle yoga practices were considered appropriate by the yoga providers, with a perception that a potential interplay between yogic poses, breathing practices, and meditation and relaxation practices could help impart mind-body (holistic) benefits in arthritis. Creating a safe and supportive environment in yoga sessions, being empathetic towards attendees' needs, and offering tailored modifications were perceived to be important for delivering yoga in arthritis treatment. Major challenges to yoga delivery in arthritis treatment included inadequate promotion of yoga, the unregulated nature of yoga delivery, and the absence of evidence-based arthritis- specific yoga training.

In conclusion, this thesis provides evidence showing yoga's potential as a complementary approach to arthritis treatment within the UK context. By synthesising evidence from global RCTs and qualitative studies, it identifies some consistent key features, including content, structure, and delivery characteristics, that emerged across effective yoga interventions for major types of arthritis in the UK, and highlights the key factors influencing participation in yoga for arthritis treatment. These findings can inform the adaptation and validation of yoga programmes for the UK healthcare setting and guide the development of and access to arthritis-specific yoga training for yoga providers, using the best available scientific evidence. Strengthening the evidence base through rigorous, long-term RCTs and improving the accessibility, regulation, and promotion of yoga could support its effective integration into arthritis treatment in the UK.

Contribution of the PhD student

I was responsible for all aspects of this thesis, including conceptualising the study, developing the research questions, and drafting the Abstract and Introduction chapter. For Chapters Two, Three, and Four, I drafted the review protocols, conducted the database searches, screened studies, and extracted and synthesised data, with assistance from second reviewers and guidance from supervisors and co-authors. In Chapter Five, I drafted the protocol, obtained ethics approval, conducted all qualitative interviews, analysed and interpreted the data, and discussed their implications. I wrote and prepared the manuscripts for all four chapters for publication, incorporating feedback from co-authors. I also drafted the abstract as well as the general discussion and conclusion chapters of the thesis. Supervisors and co-authors provided feedback on drafts but did not carry out any of the research tasks.

*All four empirical chapters of this thesis have been published or are accepted for publication (Chapter Four).

Published papers

1. Biswas I, Kaur J, Pearce F, Lewis S, Chattopadhyay K. Key features of effective yoga interventions in addition to standard medical treatment for rheumatoid arthritis: a systematic review and meta-analysis. ACR Open Rheumatol. 2025;7(5). doi:10.1002/acr2.70054.

2. Biswas I, Adebusoye B, Lewis S, Chattopadhyay K. Clinical knowledge, experiences, and perceptions of yoga providers in arthritis treatment: a UK-based qualitative study. Rheumatol Int. 2025;45:88. doi:10.1007/s00296-025-05843-1.

3. Biswas I, Nalbant G, Lewis S, Chattopadhyay K. Key characteristics of effective yoga interventions for managing osteoarthritis: a systematic review and meta-analysis. Rheumatol Int. 2024;44. doi:10.1007/s00296-024-05652-y.

4. Biswas I, Lewis S, Chattopadhyay K. Content, structure and delivery characteristics of yoga interventions for the management of osteoarthritis: a systematic review protocol. Int J Environ Res Public Health. 2022;19(10). doi:10.3390/ijerph19105806.

5. Biswas I, Lewis S, Chattopadhyay K. Content, structure and delivery characteristics of yoga interventions for managing rheumatoid arthritis: a systematic review protocol. Int J Environ Res Public Health. 2022;19(10).doi:10.3390/ijerph19106102.

Conference presentations

1. Biswas I, Nalbant G, Lewis S, Chattopadhyay K. Content, structure, and delivery characteristics of effective yoga interventions for managing osteoarthritis symptoms: a systematic review and meta-analysis. Oral presentation at: Sue Watson Oral Presentation Event, School of Medicine, University of Nottingham; 22 March 2024.

2. Biswas I, Nalbant G, Lewis S, Chattopadhyay K. Content, structure, and delivery characteristics of effective yoga interventions for managing osteoarthritis symptoms: a systematic review and meta- analysis. In-person poster presentation at: WCO-IOF-ESCEO 2024 – World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases; 13 April 2024; London. Published in: Aging Clin Exp Res. 20 August 2024.

3. Biswas I, Nalbant G, Lewis S, Chattopadhyay K. Content, structure, and delivery characteristics of effective yoga interventions for managing osteoarthritis symptoms: a systematic review and meta-analysis. Oral and poster presentation at: PGR Research Impact Forum, School of Medicine, University of Nottingham; 15 June 2023.

4. Biswas I, Nalbant G, Lewis S, Chattopadhyay K. Content, structure, and delivery characteristics of effective yoga interventions for managing osteoarthritis symptoms: a systematic review and meta-analysis. Oral presentation at:

Lifespan and Population Health (LPH) Unit Festival, School of Medicine, University of Nottingham; 12 July 2023.

5. Biswas I, Kaur J, Pearce F, Lewis S, Chattopadhyay K. Key features of effective yoga interventions for treating rheumatoid arthritis: a systematic review and meta-analysis. ePoster presented at: British Society for Rheumatology Annual Conference; 30 April 2025; Manchester. Published in: Rheumatology. 28 April 2025.

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understanding during both the challenging and happy times of this journey.

List of abbreviations

ACPAs	Anti-citrullinated protein antibodies
ACR	American College of Rheumatology
AF	Arthritis Foundation
AIMS	Arthritis Impact Measurement Scales
Anti-CCP	Anti-cyclic citrullinated peptide
AUSCAN	AUStralian CANadian Osteoarthritis Hand Index
AYUSH	Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homoeopathy
BCE	Before Common Era
bDMARDs	Biologic Disease-Modifying Anti-Rheumatic Drugs
BSR	British Society for Rheumatology
BWY	British Wheel of Yoga
CDAI	Clinical Disease Activity Index
CI	Confidence Interval
CNHC	Complementary and Natural Healthcare Council
COREQ	Consolidated Criteria for Reporting Qualitative Research
CPD	Continual Professional Development
CPGs	Clinical Practice Guidelines
CPRD	Clinical Practice Research Datalink
CRP	C-reactive protein
csDMARDs	Conventional Synthetic Disease-Modifying Anti-Rheumatic Drugs
DALY	Disability-adjusted life years
DAS28	Disease Activity Score in 28 Joints
DASH	Disabilities of the Arm, Shoulder, and Hand
DHI	Duruöz Hand Index
DMARDs	Disease-Modifying Anti-Rheumatic Drugs
ENTREQ	Enhancing Transparency in Reporting the Synthesis of Qualitative Research
ESCEO	European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases
ESR	Erythrocyte Sedimentation Rate
EULAR	European League Against Rheumatism
FAAM	Foot and Ankle Ability Measure
GBD	Global Burden of Disease

GCs	Glucocorticoids
GP	General Practitioner
GRADE	Grading of Recommendations, Assessment, Development and Evaluation
HAQ	Health Assessment Questionnaire
HAQ-DI	Health Assessment Questionnaire Disability Index
HES	Hospital Episode Statistics
HLA-DRB1	Human Leukocyte Antigen Gene Complex
HOOS	Hip Disability and Osteoarthritis Outcome Score
HRQoL	Health-Related Quality of Life
IL-6	Interleukin-6
IQR	Interquartile Range
ITT	Intention-to-Treat
IYN	Independent Yoga Network
JAK	Janus Kinase
KL	Kellgren and Lawrence Grading System
KOOS	Knee Injury and Osteoarthritis Outcome Score
MCIDs	Minimal Clinically Important Differences
MCP	Metacarpophalangeal
MD	Mean Difference
MRI	Magnetic Resonance Imaging
MTP	Metatarsophalangeal
MTX	Methotrexate
NCCIH	National Center for Complementary and Integrative Health
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NIMHANS	National Institute of Mental Health and Neurosciences
NRAS	National Rheumatoid Arthritis Society
NRS	Numeric Rating Scale
NSAIDs	Nonsteroidal Anti-Inflammatory Drugs
OARSI	Osteoarthritis Research Society International
OHS	Oxford Hip Score
OKS	Oxford Knee Score
OMERACT	Outcome Measures in Rheumatology
PGA	Patient Global Assessment
PIP	Proximal Interphalangeal
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PROMs	Patient-Reported Outcome Measures
PROSPERO	International Prospective Register of Systematic Reviews
RCT	Randomised Controlled Trial
REML	Restricted Maximum Likelihood
RF	Rheumatoid Factor
SD	Standard Deviation
SDAI	Simplified Disease Activity Index
SDPIS	Simple Descriptive Pain Intensity Scale
SE	Standard Error
SERA	Scottish Early Rheumatoid Arthritis
SF-36	36-Item Short Form Survey
SJC	Swollen Joint Count
SMD	Standardised Mean Difference
SUMARI	System for the Unified Management, Assessment and Review of Information
TJC	Total Joint Count
TMJs	Temporomandibular Joints
TNFα	Tumour Necrosis Factor-alpha
tsDMARDs	Targeted Synthetic Disease-Modifying Anti-Rheumatic Drugs
UK	United Kingdom
USA	United States of America
VAS	Visual Analogue Scale
VAS GH	Visual Analogue Scale for General Health
VEGF	Vascular Endothelial Growth Factor
WHO	World Health Organization
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index
YAP	Yoga Alliance Professionals
YLD	Years-lived with Disability
YTT	Yoga Teachers Together

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Chapter One: Introduction

This introductory chapter lays the foundation for the thesis by providing an overview of arthritis, including its definition, aetiology, risk factors, pathophysiology, clinical features, diagnosis, epidemiology, burden, and treatment, with a focus on the two major types: osteoarthritis and rheumatoid arthritis. It highlights why these conditions represent a growing public health concern in the United Kingdom (UK). The chapter then describes yoga as a complementary treatment approach, identifying gaps in the existing evidence. Finally, it outlines the rationale, aims, and objectives of the thesis, which guide the subsequent chapters.

1.1 Types of arthritis

Arthritis is a term originating from the Greek words “arthr-” and “-itis”, which stand, respectively, for “joint” and “inflammation”, and refers to a group of chronic musculoskeletal conditions primarily affecting the joints.[1] It is typically characterised by pain, stiffness, inflammation, deformities, and restricted movement of the joints.[1,2] There are various types of arthritis, including osteoarthritis, rheumatoid arthritis, psoriatic arthritis, gout, ankylosing spondylitis, fibromyalgia, lupus, spondyloarthritis, and septic arthritis, among others.[2,3]

The World Health Organization (WHO) recognises arthritis as a major contributor to the global burden of musculoskeletal conditions, particularly osteoarthritis and rheumatoid arthritis.[4] According to the Global Burden of Disease (GBD) study, approximately 1.71 billion people worldwide were living with musculoskeletal conditions in 2019, accounting for approximately 323 million incident cases, over 150 million disability-adjusted life years (DALYs), and 118,000 deaths.[5,6] Osteoarthritis and rheumatoid arthritis are the most common types of arthritis, both globally and in the UK, and their prevalence is expected to increase due to ageing populations and other contributing factors.[2,4] As of 2021, the estimated number of people (of all ages) living worldwide with osteoarthritis and rheumatoid arthritis was 607 million people and 18 million people, respectively.[7,8]

In the UK, around 20.2 million people (about 29% of the population) live with a musculoskeletal condition, and the burden is expected to rise with an ageing population.[9,10] Of these, nearly 10 million people (about 15% of the population) have a probable diagnosis of osteoarthritis, including an estimated 5.4 million (~8%) with knee osteoarthritis and 3.2 million (~5%) with hip osteoarthritis.[10-12] In the UK, around 350,000 people are diagnosed with osteoarthritis each year.[13] Nearly 450,000 (~1% of the population) have a confirmed

diagnosis of rheumatoid arthritis, with around 27,000 new cases diagnosed annually.[10,11] Gout affects around 1.6 million adults, with about 66,000 new diagnoses per year, while psoriatic arthritis and axial spondyloarthritis affect approximately 200,000 and 60,000 adults, respectively.[14] These types of arthritis contribute further to the overall musculoskeletal burden in the UK, but to a lesser extent.[11] In 2018, osteoarthritis and rheumatoid arthritis alone cost the National Health Service (NHS) in the UK an estimated £10.2 billion, with projections estimating a rise to £118.6 billion over the next decade.[15]

Among all arthritis types, osteoarthritis and rheumatoid arthritis account for the greatest proportion of disease burden, disability, and healthcare utilisation in the UK. Osteoarthritis represents a degenerative joint disorder, whereas rheumatoid arthritis is a systemic autoimmune inflammatory condition. Together, they capture the two dominant pathological spectrums of arthritis - degenerative and autoimmune inflammatory - providing a comprehensive overview of the main forms of arthritis that significantly impact population health and healthcare systems. Given the substantial and growing burden of these conditions, the subsequent sections of this thesis provide detailed discussions of osteoarthritis and rheumatoid arthritis, covering their definitions, aetiology and

risk factors, pathophysiology, clinical features, diagnosis, epidemiology, burden, and treatment, while also highlighting their distinguishing features. The section below provides an overview of osteoarthritis, including its definition, aetiology, risk factors, epidemiology and burden, and treatment. By outlining the key clinical and biological features of osteoarthritis, this section sets the context for why osteoarthritis was selected as a focus in this thesis and links to later discussions on yoga interventions that may be beneficial as a complementary approach for its treatment.

1.2 Osteoarthritis

1.2.1 Definition

Osteoarthritis, also known as degenerative joint disease, is a condition characterised by progressive deterioration of synovial joints over time.[16]

1.2.2 Aetiology and risk factors

The exact aetiology of osteoarthritis remains unclear.[16] Primary osteoarthritis arises without a clear underlying cause; a complex interplay of several known risk factors contributes to disease onset and progression, as mentioned below:[16-22]

Ageing: Characterised by the progressive loss of tissue and organ function over time, represents the single greatest risk factor for osteoarthritis.[16-19]

Sex: Females are generally more susceptible to osteoarthritis due to factors such as gender differences in ligament strength, bone density, pregnancy, and menopause.[16-19]

Race and ethnicity: May influence the risk of osteoarthritis, although the mechanisms are not fully understood.[21] Racial and ethnic classifications in some research contexts are often combined; for example, “African American” may be used as a racial category, whereas “non-Hispanic white” reflects a combined racial-ethnic classification. Evidence indicates that African Americans experience higher pain severity and greater disability in osteoarthritis compared to non-Hispanic white individuals.[21] A meta-analysis of 61 studies reported higher self-reported pain (standardised mean difference (SMD) 0.57; 95% confidence interval (CI): 0.54 to 0.61) and higher self-reported disability (0.38; 95% CI: 0.22 to 0.54) in African Americans, as well as poorer performance on functional tests (-0.58; 95% CI: -0.72 to -0.44).[21]

Nutritional deficiencies: Insufficient intake of vitamins D, C, and K may impair cartilage health and joint function.[17]

Genetic predisposition: A family history of osteoarthritis and mutations in genes, namely COL2A1, are known to increase susceptibility.[17,20]

Obesity: Excess body weight increases mechanical stress on weight-bearing joints (especially knees and hips) and disrupts immune homeostasis, potentially leading to joint inflammation.[16-18]

Physical inactivity: Sedentary lifestyles may accelerate cartilage degeneration, while moderate physical activity levels have shown protective roles, although this may vary with age and gender.[22]

In contrast, secondary osteoarthritis develops as a consequence of pre-existing conditions.[16,17] For instance, a history of knee trauma is widely recognised as a significant contributor to knee osteoarthritis, as it may initiate cartilage inflammation and alter joint biomechanics.[18] Other factors include previous joint injuries (e.g., sports-related), repetitive stress from occupational or athletic activities, muscle weakness, other types of arthritis such as rheumatoid arthritis and gout, obesity, and metabolic disorders.[16,17]

1.2.3 Pathophysiology

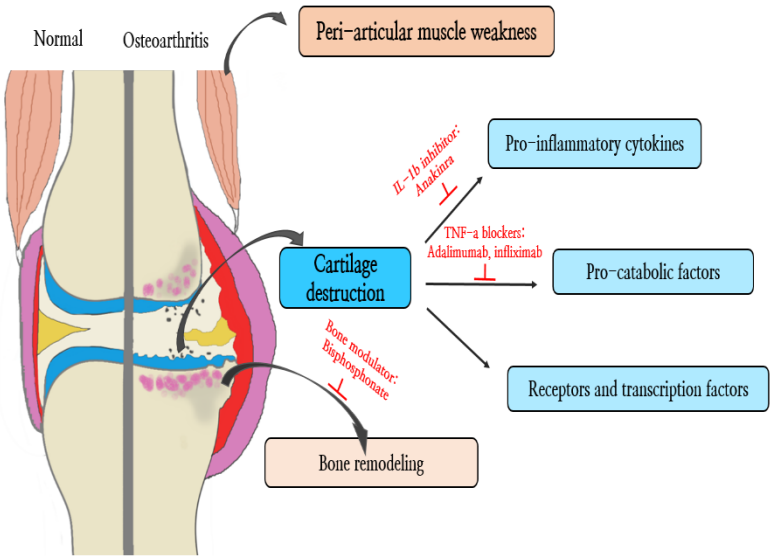


Figure 1 Mechanisms contributing to osteoarthritis progression.[23] Reproduced from: Kim JR, Yoo JJ, Kim HA. Therapeutics in osteoarthritis based on an understanding of its molecular pathogenesis. Int J Mol Sci. 2018;19(3):10.3390/ijms19030674. Licensed under CC BY. No changes made.

Osteoarthritis affects synovial joints, where bones meet and are separated by a fluid-filled cavity that allows smooth movement.[16] Figure 1 illustrates the key mechanical and inflammatory processes that drive these pathological changes.[23] Although traditionally considered a "non-inflammatory" condition, growing evidence suggests that inflammation plays a role in both its onset and progression, implicating both mechanical and inflammatory mechanisms.[24,25] Historically, research has focused on cartilage and subchondral bone.[16] However, it is now being increasingly recognised that osteoarthritis involves all components of a joint, including articular cartilage,

fibrocartilage, subchondral bone, synovium and joint capsule, ligaments, menisci, and periarticular muscles.[16,26] The pathological features of osteoarthritis include breakdown of articular cartilage, osteophyte formation (bony outgrowths), subchondral bone remodelling, and thickening of the synovial membrane and joint capsule.[16,26]

Early pathological changes include cartilage degeneration, which begins with the loss of proteoglycans and disruption of collagen structures, disrupting the smooth joint surface.[16] Excess loss of cartilage leads to friction between bones, alters joint shape, and may eventually force the bones to move away from their normal position.[16] Biochemical factors, including inflammatory cytokines like interleukin-6 (IL-6), monokines, interferon-induced protein-10, and macrophage chemotactic protein, stimulate the release of proteolytic enzymes (e.g., matrix metalloproteinases, serine proteases, cysteine proteinases) that further degrade the cartilage matrix components, leading to joint damage.[16,26,27] Osteophytes, or bony outgrowths, typically form at joint margins, possibly in response to mechanical stress and cartilage loss.[16,26] An imbalance in bone remodelling, i.e., favouring bone formation over resorption, leads to osteophyte formation, subchondral sclerosis (hardening of the subchondral bone; a key feature of advanced stages of osteoarthritis), and structural changes that

contribute to joint space narrowing.[16] In addition, synovial inflammation is a key pathological feature of osteoarthritis, characterised by thickening of the synovial membrane and elevated levels of proinflammatory cytokines in the synovial fluid.[16,26] This inflammatory process promotes cell proliferation and contributes to the thickening of the joint capsule (which surrounds and protects the joint), further impairing joint function and contributing to the progression of the condition.[16,26]

1.2.4 Clinical features

Understanding of clinical features is crucial for accurate diagnosis and treatment of osteoarthritis.[16,28] The clinical presentation of osteoarthritis includes both observable signs and patient-reported symptoms.[28] Physical signs may vary according to the affected joint, but these typically include joint tenderness, bony enlargement of joints in fingers and toes, crepitus during movement, an altered gait, and limited range of movement due to pain, bony swelling, and joint deformity.[16,28,29] There may also be modest soft-tissue swelling, an effusion, and eventual muscle weakness.[16,28,29] The triad of symptoms mainly includes pain, stiffness, and difficulty in movement.[16,28] Pain is the predominant symptom, typically worsened by joint use (e.g., weight-bearing on large joints) and relieved by rest.[16,28] As the condition progresses,

pain may become persistent and disrupt sleep.[16,28] Two distinct pain patterns are often described: predictable pain, which becomes constant over time and is accompanied by stiffness after prolonged periods of inactivity; and unpredictable pain, which occurs for short durations and can be emotionally distressing and affect the individual's daily activities.[29] Stiffness is another hallmark symptom, usually lasting less than 30 minutes and typically occurring after periods of inactivity.[16,28] Additionally, difficulty in movement may be caused by the formation of osteophytes and the thickening of the joint capsule.[16,28] Swelling and increased fluid in the synovium can also contribute to limited motion.[16,28]

Additional symptoms include deformity, crepitus, and tenderness in joints.[30] Joint deformity commonly arises from osteophyte formation, which alters the shape of the joint.[16,30] Crepitus refers to a grinding or clicking sensation during passive joint movement, resulting from progressive cartilage loss, increased roughness of joint surfaces, friction, and additional strain on the damaged surfaces.[16,30] Tenderness along the joint line typically signifies articular involvement, whereas tenderness distant from the joint may indicate periarticular soft tissue conditions (range of disorders affecting the tissues surrounding joints, including muscles,

tendons, ligaments, and the joint capsule), which can co-exist with osteoarthritis.[16,30]

Based on the pain patterns described above, osteoarthritis progresses through the following stages[30]:

Early-stage: Predictable sharp pain that limits the individual's ability to participate in high-impact activities.

Mid-stage: Both predictable and unpredictable pain and stiffness in joints, with the pain becoming increasingly constant over time and affecting daily life activities.

Advanced stage: Persistent dull pain with intermittent short episodes of unpredictable, intense pain that results in a significant impact on daily life and social activities.[30]

Symptoms may fluctuate in severity from day to day, but in general, they change only slowly with time.[28] Although osteoarthritis can affect any joint in the body, it most commonly involves the small joints of the hands (proximal and distal interphalangeal joints and first carpometacarpal joints), as well as the knees, hips, and feet (first metatarsophalangeal joints).[16,28] The spine, especially the lower cervical and lumbar regions, may also be affected.[28]

Initially, osteoarthritis was considered to predominantly affect a single joint or a small number of joints (typically two to four), but emerging evidence indicates that the majority of cases involve multiple joints.[16,28] The condition typically manifests in an asymmetrical distribution, meaning it generally does not affect the same joints on both sides of the body at a time.[16,28] It predominantly affects people aged over 40 years.[28]

1.2.5 Diagnosis

Osteoarthritis has no specific laboratory diagnostic test, and the diagnosis is primarily clinical.[16,28] Clinicians rely on a physical examination and characteristic symptoms, such as joint pain and morning stiffness lasting less than 30 minutes (as discussed above).[16,31] Imaging techniques play a critical role in confirming osteoarthritis and assessing its severity.[16,32]

X-ray (plain radiography) is the first-line imaging technique in clinical practice for confirming osteoarthritis, particularly of the hands and knees.[16,28,32] Radiographic findings, including osteophyte formation and joint space narrowing, are considered hallmark indicators of osteoarthritis. Radiographs have long been considered the gold standard in defining osteoarthritis, and there are several ways to interpret radiographic findings.[32] The Kellgren and Lawrence (KL)

grading system is the most widely used radiographic classification, assigning scores from 0 (no osteoarthritis) to 4 (severe osteoarthritis), based on structural changes of the joint.[33]

Other advanced imaging techniques include Magnetic Resonance Imaging (MRI), which is more sensitive than X-rays for detecting early cartilage changes and soft tissue involvement, and is particularly useful when the diagnosis is uncertain or when early osteoarthritis is suspected.[28,32] Ultrasound offers a cost-effective and portable tool to assess peripheral joints for synovial inflammation, osteophytes, and effusions[32], though it is less sensitive than MRI in detecting joint space narrowing.[34]

Laboratory and imaging tests are typically used to exclude other conditions, such as fractures or conditions such as rheumatoid arthritis or gout.[30] Levels of inflammatory markers, such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), are usually normal in osteoarthritis.[30] Emerging research is investigating the role of biomarkers in the early detection and monitoring of osteoarthritis progression, though their clinical utility remains under evaluation.[35]

1.2.6 Epidemiology and burden: worldwide and in the UK

Osteoarthritis is a leading global cause of disability and a primary contributor to years lived with disability (YLDs) from musculoskeletal conditions.[36] According to the GBD study 2021, approximately 595 million people were living with osteoarthritis by 2020, which is 7.6% of the global population, and accounting for 2.2% of global YLDs.[7] This represents a 132.2% increase in prevalence since 1990, with further increases projected by 2050.[7] Joint-specific burden varies significantly, with knees accounting for 60.9% of global osteoarthritis-related YLDs, hands 23.5%, hips 5.5%, and other joints (e.g., feet, shoulders, wrists) 10.2%.[7] By 2050, knee osteoarthritis is projected to increase by 74.9%, hand osteoarthritis by 48.6%, hip osteoarthritis by 78.6%, and osteoarthritis in other joints by 95.1%.[36] Age-standardised prevalence is estimated at 8% in women and 5.8% in men globally.[36]

The 2015 WHO Global Ageing and Health Report highlights osteoarthritis as a leading cause of disability in adults aged 60 years and older.[37] A systematic review of 34 cross-sectional studies (n = 80,000) spanning a duration of 25 years up to 2018 found a pooled global prevalence of 16.05% (95% confidence interval (CI) 12.55 to 19.89%).[38] The highest regional estimates were reported in South Asia (16.4%),

followed by East Asia and the Pacific (15.7%), and Sub-Saharan Africa (14.2%).[38]

Osteoarthritis causes significant pain and functional impairment, which often leads to reduced physical activity, and this can further worsen their condition, particularly in those who are inactive.[39] It is also associated with multiple comorbidities (additional health conditions), including stroke, hypertension, peptic ulcer disease, and mental health conditions such as anxiety and depression, due to increased pain perception.[40,41] Pain and depression frequently co-exist and exacerbate each other in osteoarthritis.[40] Individuals with osteoarthritis are 1.2 times more likely to have any comorbidity and 2.5 times more likely to have three or more comorbidities, compared to those with no osteoarthritis.[41] Although osteoarthritis is not directly linked to increased mortality, it is associated with higher cardiovascular disease-related mortality, likely due to physical inactivity and overlapping risk factors.[42] Further research is needed to determine the causality between osteoarthritis and these common comorbidities to improve the treatment and prevention of osteoarthritis. Mental health burden in osteoarthritis is substantial, with high levels of stress, anxiety, and depression reported, all of which can contribute to poor health-related quality of life.[43-47] A meta-analysis showed that

people with osteoarthritis had significantly lower health-related quality of life (HRQoL) scores across all domains of the 36-Item short form survey (SF-36) compared to the general population.[44] Beyond health impacts, chronic pain and limited mobility in osteoarthritis often reduce people's ability to work, restrict social participation, increase isolation, and negatively affect overall quality of life and well-being.[45-47]

The economic burden of osteoarthritis is substantial, comprising both direct and indirect costs.[45,48] Direct costs include expenses for pharmacological and non-pharmacological treatments, joint replacement surgeries, hospitalisations, and managing treatment complications, and indirect costs include absenteeism, reduced work productivity, disability compensation, and premature mortality.[45,48]

In the UK, approximately 10 million people (adults) live with a probable diagnosis of osteoarthritis, with a higher prevalence among women.[10,11] A 1997-2017 study using the UK Clinical Practice Research Datalink (CPRD) database (the UK's large, prospective primary care electronic medical record database) reported a prevalence of 10.7% for symptomatic osteoarthritis, with the knee being the most commonly affected joint.[13] The incidence was 6.8 per 1,000 person-years (95% CI 6.7 to 6.9), with notable regional

variation: Scotland and Northern Ireland had the highest prevalence, while the East Midlands had the highest incidence.[13] Trends from NHS Hospital Episode Statistics (2000-2018) showed rising incidence in the hand (10.9%), foot and hip (3.8%), particularly among younger adults for hip osteoarthritis, while knee (2.9%) osteoarthritis incidence declined overall.[49] Although more women were diagnosed overall, men had higher incidence rates of hand and hip osteoarthritis.[49] A matched retrospective cohort study using the CPRD GOLD (a large primary care data source that was established in 1987) found that individuals with osteoarthritis had significantly higher general practitioner consultations, hospital admissions, and nearly double the mortality rate compared to controls.[50] A report by the National Institute for Health and Care Excellence (NICE) indicated that about 80% of people with osteoarthritis have at least one comorbid condition, such as cardiovascular disease or depression.[9] Further analysis combining CPRD and Hospital Episode Statistics (HES) data indicated that, within the first year following diagnosis, the mean healthcare costs for osteoarthritis-related chronic pain patients in England were nearly four times those of matched controls and remained elevated for at least three years.[51] This economic burden was largely driven by an increase in inpatient care, particularly joint replacement surgeries, as well as hospital admissions

and general practitioner (GP) consultations, with inpatient stays alone accounting for over 75% of total healthcare expenditures in the first six months.[51]

1.2.7 Treatment

The treatment of osteoarthritis has progressed from a narrow focus on pain relief to a broader and comprehensive approach aimed at improving function and health-related quality of life while slowing or preventing disease progression.[16,52] Current treatment approaches combine pharmacological and non-pharmacological interventions, guided by multiple international clinical practice guidelines (CPGs), including those from the NICE, the American College of Rheumatology (ACR)/Arthritis Foundation (AF), the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases (ESCEO), the European Alliance of Associations for Rheumatology (EULAR), and the Osteoarthritis Research Society International (OARSI).[52-56]

Pharmacological treatments commonly include oral, topical, and intra-articular options.[53-56] Oral nonsteroidal anti-inflammatory drugs (NSAIDs) (e.g., ibuprofen) are considered the first-line treatment but are associated with gastrointestinal, cardiovascular, renal, hepatic, and

hematologic side effects.[53-56] Topical NSAIDs (e.g., diclofenac gel) have shown similar efficacy in pain relief and improvement in function.[57] Although topical NSAIDs have fewer gastrointestinal and systemic side effects than oral forms, they may cause local skin irritation.[58] Intra-articular corticosteroid injections may provide short-term relief from pain and improve function, but using this more than once every four months can result in cartilage and joint damage.[59] The side effects and costs associated with pharmacological interventions are some of the reasons why people with osteoarthritis might be reluctant to use them.[60] These concerns are amplified in patients with multimorbidity[60], where NSAIDs are often contraindicated. Given these limitations, non-pharmacological treatments have gained global prominence.[61,62]

Non-pharmacological treatments include patient education, self-management, exercises to improve muscle strength (e.g., targeting hamstring muscles in knee osteoarthritis), and weight loss in overweight or obese individuals, which are consistently emphasised.[53-56] Practices such as yoga are conditionally recommended, particularly for knee osteoarthritis, although the supporting evidence is limited.[53,55] Managing obesity and promoting physical activity not only improves clinical outcomes but may also reduce dependence

on NSAIDs and opioids, particularly in people with osteoarthritis.[61] A systematic review found that structured exercise programmes, particularly strength training and aerobic exercise, resulted in a significant reduction in pain and functional disability in knee osteoarthritis patients, with weight loss contributing to a 20-30% improvement in clinical outcomes.[61] An umbrella review of 57 systematic reviews conducted in 19 countries (mostly in China, followed by India, and Australia) assessed the effectiveness of 24 distinct non-pharmacological interventions for knee osteoarthritis.[62] It found strong and moderate evidence supporting the effectiveness of some of these interventions, namely diet therapy, patient education, resistance training as core interventions, moderate evidence for aquatic therapy, balance training, and Tai Chi, among others.[62]

Surgical treatments, such as total joint replacements, are needed when other treatments have not been effective or in cases of severe joint damage.[53-56] Surgical interventions, namely total knee arthroplasty and unicompartmental knee arthroplasty, were found to have the lowest risk with improved function, and knee joint distraction had the maximum risk of complications and re-operations.[63]

In the UK, osteoarthritis treatment is guided by the NICE guideline, which emphasises non-pharmacological interventions as the foundation of treatment, prioritising therapeutic exercise and weight management as first-line treatments.[52] Pharmacological treatments are recommended as adjuncts, with NSAIDs prescribed at the lowest effective dose for the shortest possible duration.[52] Intra-articular corticosteroid injections are reserved for cases where other options have proven ineffective or are used in support of non-pharmacological strategies.[52]

Self-management for osteoarthritis care is strongly recommended by NICE.[52] Adults with osteoarthritis should be provided with tailored information about their condition, including guidance on symptom management, treatment options, and lifestyle modifications, enabling them to take an active role in their care. Key self-management strategies include therapeutic exercise, such as muscle strengthening and aerobic activity, weight management for those who are overweight or obese, and appropriate use of manual therapies alongside exercise.[52] NICE emphasises that most adults with osteoarthritis can self-manage using these strategies, with healthcare professionals supporting follow-up and review as needed to monitor progress, address concerns, and optimise outcomes. These approaches improve function, reduce pain,

and enhance quality of life.[52] Surgical intervention is considered only when both pharmacological and non-pharmacological approaches have failed to provide adequate symptom relief.[52]

A key recommendation common to both UK and international guidelines is the development of an individualised management plan tailored to the patient's symptoms, comorbidities, and personal goals; a strategy encouraged even though high-quality evidence is limited.[52-56]

The following flowchart (Figure 2) illustrates the typical patient journey in osteoarthritis, highlighting the role of primary care in early detection of symptoms, referral to an orthopaedic surgeon, diagnosis, treatment initiation, ongoing self-management, and potential challenges to it.

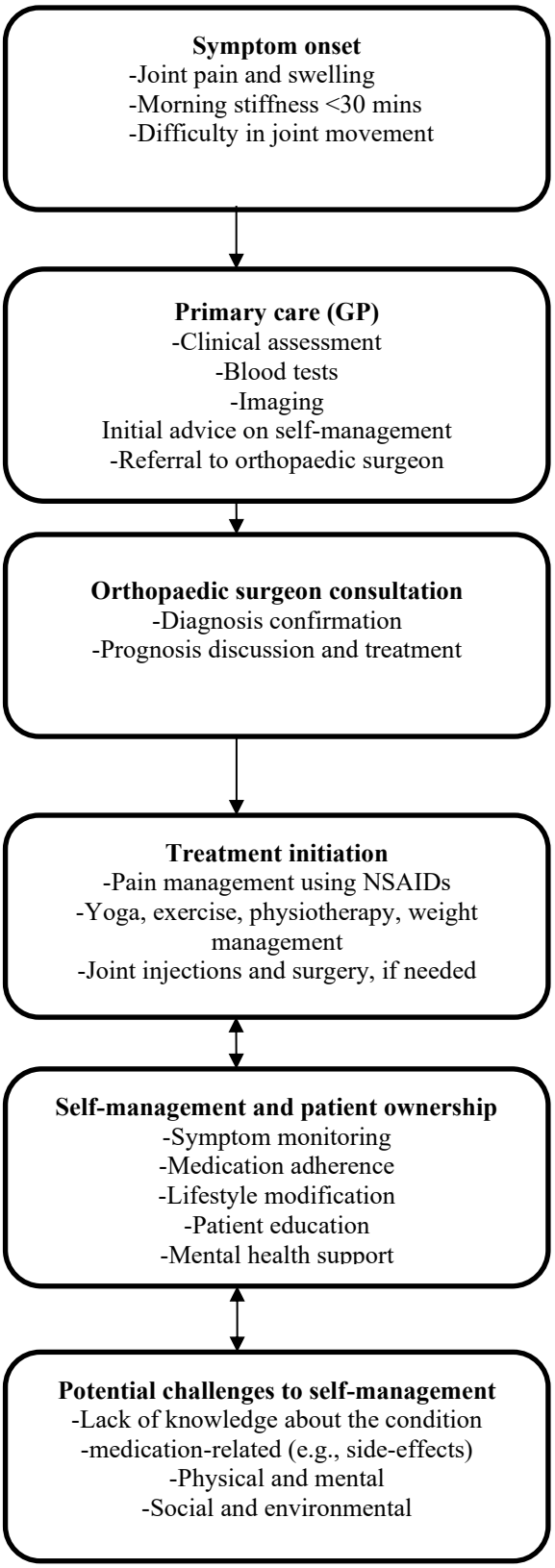


Figure 2 Typical patient journey in the osteoarthritis care pathway.

1.2.8 Clinical outcomes and their measurement

Key clinical outcomes of osteoarthritis include pain, physical function, stiffness, and health-related quality of life (HRQoL).[64,65] These are commonly assessed using patient-reported outcome measures (PROMs) in both research and clinical practice.[64,65] PROMs provide insights into patients' perspectives and support individualised treatment based on their needs.[64] These are typically questionnaire-based and assess the severity, frequency, and impact of symptoms, enabling a consistent and objective evaluation of disease progression and treatment effectiveness.[65] PROMs may be generic (e.g., Visual Analogue Scale (VAS) for measuring pain), disease-specific (e.g., Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for measuring pain, function, and stiffness in osteoarthritis), or joint-specific (e.g., Knee Injury and Osteoarthritis Outcome Score (KOOS) in knee osteoarthritis).[65] To ensure consistency in outcome reporting, the Outcome Measures in Rheumatology (OMERACT) initiative, in collaboration with the OARSI, has developed a core set of outcome measures that must be assessed and reported in all clinical trials.[66,67] Table 1 summarises commonly used PROMs in osteoarthritis, including details on scoring and interpretation, while Table 2 presents key joint-specific measures relevant to osteoarthritis.

Table 1 Commonly used outcome measurement scales (PROMs) in osteoarthritis.

Outcome	Scale	Description	Scoring and interpretation
Pain	Simple Descriptive Pain Intensity Scale (SDPIS)[68]	• Measures pain intensity. • Self-reported.	• Total score: 0 to 5 • 0 = no pain • 5 = worst possible pain
	Visual Analogue Scale (VAS)[69]	• Measures pain intensity. • Consists of a single-item scale with a 10 cm ruler. • Self-reported.	• Total score: 0 to 100 mm • 0 = no pain • 100 = worst possible pain
	Numeric Rating Scale (NRS)[69]	• A modified version of the VAS that measures pain intensity. • Consists of a segmented numerical scale with 11 points. • Self-reported.	• Total score: 0 to 10 • 0 = No pain • 10 = worst possible pain
Function	Health Assessment Questionnaire Disability Index (HAQ-DI)[70]	• To measure functional ability in 20 activities of daily living. • Comprises 20 items across 8 domains, including dressing, standing, eating, walking, hygiene, reaching, gripping, and usual activities. • Self-reported.	• Total score: 0 to 3 • 0–1=mild/moderate disability • 1–2=moderate/severe disability • 2–3=severe/very severe disability Each domain has a set of questions scored from 0 to 3. • Overall score is the mean of the 8 domain scores.

	Arthritis Impact Measurement Scales (AIMS) expanded and revised to AIMS2[71]	• To measure functional ability. • Consists of 78 items in 12 areas of health (mobility level, walking and bending, hand and finger function, arm function, self-care tasks, household tasks, social activity, support from family and friends, pain, work, level of tension, mood). • These areas are aggregated into five major dimensions (physical functioning, social interaction, pain, work and affect). • Self-reported.	• Total score: 0 to 10 • Higher scores indicate worse health.
	Short Form-36 Health Survey (SF-36)[69]	• To measure overall health status. • Consists of 36 items across 8 domains, including vitality, physical functioning, bodily pain, general health, physical role functioning, emotional role functioning, social role functioning, and mental health. • Self-reported.	• Total scores are weighted sums of items in each domain. • Each domain score: 0– 100. • Higher scores indicate better health.

Table 2 Joint-specific scales for outcome measures in osteoarthritis.

Joint	Scale	Description, scoring, and interpretation
Knee and hip	Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)[72]	• 24-item scale consisting of three subscales: pain, stiffness, and physical function. • Scores are interpreted by summing the scores from each subscale to obtain a total score. • Total score ranges from 0 to 96, with higher scores indicating worse pain, stiffness, and functional limitations. • Self-reported.
Knee	Knee Injury and Osteoarthritis Outcome Score (KOOS)[73]	• 42-item scale consisting of five subscales: pain, symptoms, daily activities, sports and recreational activities, and QoL. • The five subscales are separately scored and converted to 0 to 100 points, with 0 indicating most problems and 100 indicating no knee problems. • Self-reported.
	Oxford Knee Score (OKS)[74]	• 12-item scale to assess function and pain after total knee replacement surgery. • Each item is scored between 1 and 5. • The total score ranges from 12 to 60, with higher scores representing worse results. • Self-reported.
Hip	Hip Disability and Osteoarthritis Outcome Score (HOOS)[75]	• An adapted scale of KOOS, consisting of 40 items and five subscales (pain, symptoms, activity of daily living, sport and recreation function, and hip related quality of life) • All items are scored from 0 to 4, and each of the five subscales was calculated as the sum of the items included. • Each subscale is separately scored and converted to a 0–100 score, 0 indicating worst to 100 indicating best hip condition. • Self-reported.
	Oxford Hip Score (OHS)[74]	• 12-item scale that evaluates two domains - function and pain after hip replacement surgery. • Each item has five possible responses. • Scores range from 0 to 4, where 0 represents the worst outcome and 4 represents the best.

		• Self-reported.
Hand	Duruöz Hand Index (DHI)[76]	• Consists of 18 questions regarding ability to carry out manual tasks. Questions are grouped in five domains: In the kitchen, dressing, hygiene, in the office, and other. • Individual items are scored on a 0 (without difficulty) to 5 (impossible) scale. The 18 individual scores are summed to obtain a composite score. • The total score ranges from 0 (good function) to 90 (poor function). • Self-reported.
	AUStralian CANadian Osteoarthritis Hand Index (AUSCAN)[76]	• Consists of a 15-item scale, including three subscales - pain, stiffness, and physical function. • Available on a five-point Likert scale, VAS, or NRS. • Lower scores indicate better outcomes. • Self-reported.
	Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire[76]	• Consists of 30 items, including two subscales - symptoms and daily activity's function. • The score ranges from 0 (no disability) to 100 (most severe disability). • Self-reported.

This section provides an overview of rheumatoid arthritis, including its definition, aetiology, risk factors, epidemiology and burden, and treatment. By describing the key clinical and biological features of rheumatoid arthritis, this section sets the context for why rheumatoid arthritis was selected as a focus in this thesis and links to later discussions on yoga interventions that may be beneficial as a complementary approach for its treatment.

1.3 Rheumatoid arthritis

1.3.1 Definition

Rheumatoid arthritis is a systemic autoimmune inflammatory condition, characterised by chronic inflammation of the synovial lining of joints.[77]

1.3.2 Aetiology and risk factors

It is not clear why the immune system attacks the joints in rheumatoid arthritis.[77,78] However, an interplay of genetic, sex-related and hormonal, environmental, and other factors may contribute to its occurrence.[77-81]

Genetic factors: A family history of rheumatoid arthritis and an altered genotype of the human leukocyte antigen gene

complex (HLA-DRB1) increase susceptibility to the condition.[79] Certain populations are likely to be at a higher risk for rheumatoid arthritis (e.g., populations indigenous to the Americas are at a five- to seven-times increased risk for rheumatoid arthritis compared to non-indigenous populations).[79]

Sex-related and hormonal factors: Females are at a higher risk of rheumatoid arthritis compared to males; a difference that may be linked to hormonal influences such as oestrogen.[77,78,80] Although the exact role of hormones in the development of rheumatoid arthritis remains unclear, its increased occurrence in females may be attributed to the stimulatory effects of oestrogens on the immune system, potentially contributing to autoimmunity.[77] Other hormonal factors linked to an increased risk of rheumatoid arthritis include menopause and the post-partum period.[80]

Environmental factors: Cigarette smoking is the most consistently documented environmental risk factor for rheumatoid arthritis.[77,81] Additional environmental contributors include air pollution, occupational exposures to airborne toxins, and certain dietary patterns (e.g., inflammatory diets).[77,78] Other factors, including bacterial and viral infections and stress response, could influence

autoimmune processes and contribute to the condition's onset.[78]

1.3.3 Pathophysiology

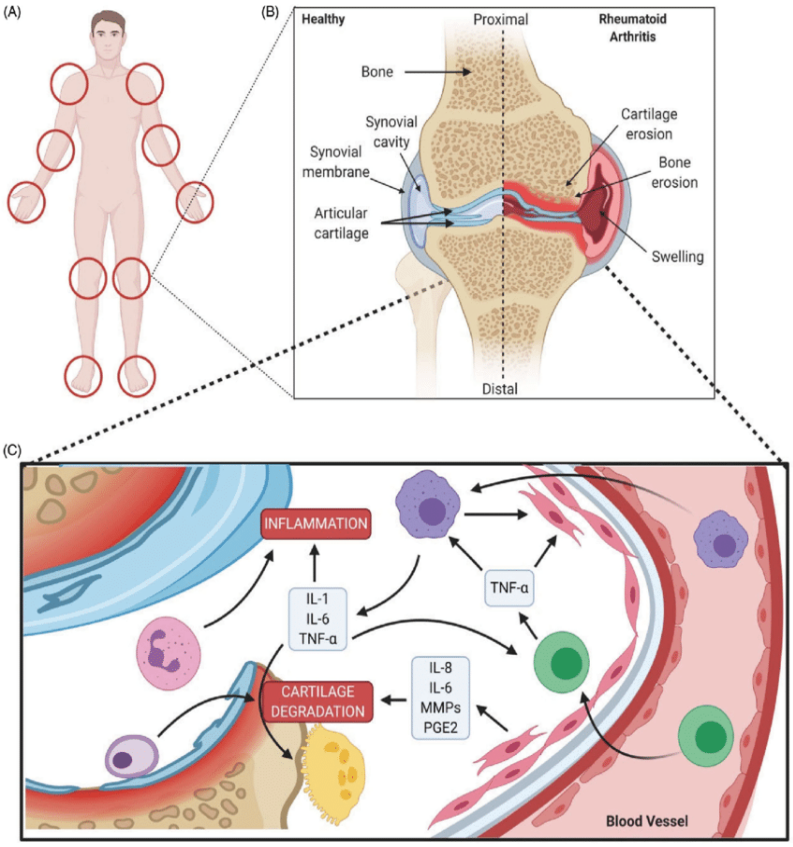


Figure 3 Overview of joint involvement and inflammatory pathways in rheumatoid arthritis.[82] Reproduced from: Akram MS, Pery N, Butler L, Shafiq MI, Batool N, Rehman MFU, et al. Challenges for biosimilars: focus on rheumatoid arthritis. Crit Rev Biotechnol. 2021;41(1):121-53. doi: 10.1080/07388551.2020.1830746. Licensed under CC BY-NC-ND. No changes were made.

Although the pathophysiology of rheumatoid arthritis is not fully understood, the process generally involves dysregulated systemic inflammation with antigen presentation, T-cell activation, and autoantibody production all serving as mediators in the inflammatory process.[77,83,84] Figure 3

provides an overview of the inflammatory mediators and cellular interactions driving rheumatoid arthritis. It primarily affects the synovial joints, where chronic inflammation is driven by elevated levels of proinflammatory cytokines such as tumour necrosis factor-alpha (TNFα) and IL-6.[77,84] This cytokine milieu leads to synovial hyperplasia (synovitis), increased vascularity, and infiltration of immune cells, including T and B lymphocytes, macrophages, fibroblasts, monocytes, and plasma cells.[77,84]

Plasma cells produce autoantibodies, particularly rheumatoid factor (RF) and anti-citrullinated protein antibodies (ACPAs), which contribute to disease severity, osteoclast activation, and local inflammation.[77,83] These autoantibodies, along with inflammatory cytokines, stimulate matrix metalloproteinases and other enzymes that degrade cartilage and extracellular matrix and promote osteoclast activation and bone resorption.[77,84] As a result, joint space narrowing, cartilage loss, and bone erosion may begin early and contribute significantly to long-term functional impairment.[77]

Leukocyte migration into the synovium is facilitated by upregulation of adhesion molecules and chemokines on synovial endothelial cells.[77,83] The inflamed synovium becomes hypoxic, likely due to hyperplasia and reduced

perfusion from increased intra-articular fluid.[77] Hypoxia, in turn, induces angiogenesis via upregulation of vascular endothelial growth factor (VEGF), sustaining leukocyte infiltration and chronic inflammation.[77] The synovial membrane becomes densely populated with inflammatory cells, orchestrating progressive joint destruction over time.[77,83] In some cases, synovial tissue may develop lymphoid follicles, further sustaining the immune response.[77]

Beyond the joints, rheumatoid arthritis can manifest systemically with features such as rheumatoid nodules formation and inflammation of the lung and cardiac tissue, contributing to the progression of the condition.[77]

1.3.4 Clinical features

Understanding the clinical presentation of rheumatoid arthritis is essential for its timely diagnosis and treatment.[77] The most notable signs of rheumatoid arthritis are joint erosions, rheumatoid nodules, and other extraarticular manifestations, which are seen primarily in patients with longstanding disease and are frequently absent during initial presentation.[85] The hallmark symptom is joint stiffness, particularly in the morning, typically lasting longer than 30 minutes.[77,85] This stiffness is often accompanied by warmth, swelling, and pain in the affected joints.[77] Other symptoms include muscle

weakness, often due to reduced use of the joint caused by pain and stiffness, and systemic manifestations such as persistent fatigue, low-grade fever, poor appetite, and unintentional weight loss, reflecting the underlying widespread inflammatory nature of the condition.[77,85] Rheumatoid nodules, which are small firm lumps, may also develop under the skin, often over pressure points such as elbows, and are more common in advanced stages of the condition.[77,85] A notable characteristic of rheumatoid arthritis is the occurrence of flares or episodes of heightened disease activity marked by worsening joint inflammation, pain, and fatigue, for a sufficient duration and intensity that requires initiation or change in treatment.[86] During phases when the symptoms are more severe, or at more advanced stages of the disease, people might sometimes feel extremely exhausted.[77] Movement of the affected joints often alleviates stiffness and discomfort in the early stages of the disease.[77] In the early stages of the disease, deformities are not seen; however, in severe or untreated disease, deformity can occur and lead to significant disability.[77]

Clinically, rheumatoid arthritis progresses through early and established stages, based on the duration of symptoms.[87] Early rheumatoid arthritis is defined as having symptoms for less than six months and established rheumatoid arthritis

refers to symptoms that persist beyond six months.[87] The disease often begins in small peripheral joints, including the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints of the hands, and the metatarsophalangeal (MTP) joints of the feet.[77,85] It may also affect the temporomandibular joints (TMJs), shoulders, wrists, elbows, knees, ankles, and the cervical spine (notably sparing the lumbar spine), where there is synovial tissue.[77] As rheumatoid arthritis progresses, it can involve larger proximal joints and, in some cases, lead to extra-articular involvement of the skin, eyes, lungs, heart, and kidneys.[77] The affected joints are usually symmetrically involved, meaning that the same joints on both sides of the body are affected at the same time and to the same extent, which is a defining clinical feature of rheumatoid arthritis.[77] Rheumatoid arthritis is classically a polyarticular disease, affecting multiple joints simultaneously, and is rarely monoarticular.[77] It generally affects those aged 45-65 years, although it can occur at any age.[77]

1.3.5 Diagnosis

Diagnosing rheumatoid arthritis can be challenging due to symptom overlap with other joint conditions.[77] Initial evaluation involves a physical examination to assess the presence of signs and symptoms, to assess the swelling of joints and their movement, as well as biomarkers such as

autoantibodies and imaging findings that can demonstrate joint damage.[77] There is no single definitive blood test for rheumatoid arthritis, but several are used in combination to support diagnosis.[77]

ESR and CRP: These are commonly elevated in rheumatoid arthritis, showing systemic inflammation.[77]

RF and anti-CCP antibodies: The presence of these serological markers i.e., autoantibodies strongly supports the diagnosis. Individuals who test positive for both are at higher risk for severe disease.[77] RF is typically considered positive at ≥20 International Units per millilitre (IU/mL) and anti-CCP at ≥10 Units per millilitre (U/mL), where IU/mL reflects internationally standardised activity and U/mL represents assay-specific units, although cut-offs may vary by laboratory.[87,88] Both antibodies have high specificity for rheumatoid arthritis, particularly anti-CCP (>95%), but moderate sensitivity (RF 60-80%, anti-CCP 70–80%).[88] This means that some patients may present with active disease despite negative RF or anti-CCP tests, highlighting the importance of clinical assessment and early treatment. Active disease is characterised by persistent joint swelling, pain, stiffness (especially >30 minutes in the morning), elevated ESR or CRP, and progressive radiographic damage.[89,90]

Patients with high titres of RF or anti-CCP are at increased risk of aggressive disease and joint erosion, underscoring the need for early intervention.[91] In addition to serological testing, imaging plays a crucial role in confirming diagnosis and monitoring disease progression.[77]

Imaging techniques such as X-rays and MRI may be used to check for joint damage and inflammation.[77] In addition, established classification criteria such as the 2010 ACR/EULAR Classification Criteria for rheumatoid arthritis are widely used to confirm its diagnosis.[87] The 2010 criteria assign a score based on four domains (Table 3)[87]:

Table 3 2010 ACR/EULAR Classification Criteria.[87]

Domain	Criteria	Scoring
A. Number and size of involved joints (0-5 points)	1 large joint (shoulders, elbows, hips, knees, and ankles)	0 point
	2–10 large joints	1 point
	1–3 small joints (metacarpophalangeal joints, proximal interphalangeal joints, second through fifth metatarsophalangeal joints, thumb interphalangeal joints, and wrists)	2 points
	4-10 small joints	3 points
	10 joints (including ≥1 small joint)	5 points
B. Serological testing for rheumatoid factor or anti-citrullinated peptide/protein antibody - (0-3 points)	Negative RF and anti-CCP	0 point
	Low-positive RF or anti-CCP	2 points
	High-positive RF or anti-CCP	3 points
C. Acute phase reactant (erythrocyte sedimentation rate [ESR] or C-reactive protein [CRP]) - (0-1 points) (determined by lab reports)	Normal CRP and ESR	0 point
	Abnormal CRP or ESR	1 point
D. Duration of symptoms (As per patient's self-report)	<6 weeks	0 point
	≥6 weeks	1 point

Note: The points from each of the domains A through D are added and the sum is considered to be the total score. A total score of ≥6 is needed to classify a patient as having definite rheumatoid arthritis.

Accurate diagnosis not only guides pharmacological treatment but also informs patient education and long-term disease management.[77] Diagnosis also provides the opportunity to educate patients on self-management strategies, which are critical for optimising long-term outcomes. Even in seronegative patients, symptoms should be actively treated to prevent progression.[92] For seropositive patients, understanding

the implications of RF and anti-CCP titres helps guide adherence to conventional medicine, monitoring, and lifestyle interventions.[92] Patient education and self-management strategies, including symptom tracking, exercise, joint protection, and flare management, are essential for optimising outcomes and reducing long-term joint damage.[77]

1.3.6 Epidemiology and burden: worldwide and in the UK

Rheumatoid arthritis is a leading cause of musculoskeletal disability globally, with a rising prevalence.[8] In 2020, an estimated 17.60 million (95% CI 15.80 to 20.30) were living with rheumatoid arthritis worldwide and this number is projected to reach 31.70 million (range: 25.80 to 39.00 million) by 2050.[8] As of 2020, rheumatoid arthritis affected 209 in every 100,000 people worldwide, marking a 14% increase since 1990.[8] Since 1990, the global burden of the condition has more than doubled, likely driven by an ageing population and potentially unidentified risk factors.[8] In the same year, rheumatoid arthritis accounted for approximately 38,300 deaths, fewer than one in 100,000 people, reflecting a 23.8% decline in mortality since 1990.[8]

Despite improvement in survival, rheumatoid arthritis has significant health, social, and economic implications due to its debilitating nature and systemic complications.[93-100] Affected

individuals experience increased pain and reduced physical function, limiting daily activities.[77] Systemic inflammation in the condition is associated with increased risks of cardiovascular complications, including myocardial infarction and stroke.[93,94] The burden is further exacerbated by complications including pulmonary, cardiovascular, neurological, and musculoskeletal involvements, osteoporosis induced by glucocorticoids (GC) use (for rheumatoid arthritis), and infection, which have significant impacts on the disease outcomes.[94]

Beyond physical health, mental health is also severely affected in this condition; depression is twice as common in people with rheumatoid arthritis compared to the general population and is the most prevalent mental health disorder associated with the condition.[95] Consequently, HRQoL is considerably reduced.[95,96]

Physical symptoms such as pain, fatigue, and limited mobility can often restrict participation in work, leisure, and family life, leading to social isolation.[47] Perceived stigma, particularly among those with severe pain or prolonged morning stiffness associated with rheumatoid arthritis, may worsen this isolation by lowering self-esteem and hindering interpersonal relationships.[97]

These physical, mental, and social burdens contribute to the substantial economic burden of rheumatoid arthritis, comprising both direct and indirect costs.[98] Direct costs encompass pharmacological treatments, hospitalisations, surgeries, and treatment-related complications, while indirect costs include absenteeism, loss of productivity, disability benefits, and premature mortality.[98] A systematic review of 72 studies found that medications accounted for 87% of direct costs, while hospitalisation costs declined over time.[98] Indirect costs, mainly due to absenteeism and work disability, constituted 39% to 86% of total costs, highlighting the long-term societal impact of the disease.[98] The decreasing trend in hospitalisation costs suggests a shift in spending toward other direct cost components, particularly medications.[98]

In the UK, the burden of rheumatoid arthritis is substantial, with rising prevalence and incidence contributing to significant health, social, and economic consequences.[99-103] According to NICE, approximately 1% of the population is affected.[99] Data from primary care electronic health records between 2004 to 2020 reported a 42.50% increase in point prevalence, rising from 0.54% to 0.78%, with the highest prevalences in people aged 75 years and older.[100] Similarly, a 2023 study involving over 22 million UK residents found that

the age-standardised incidence increased from 58.40 to 94.00 cases per 100,000 between 2000 and 2019.[101] A longitudinal analysis using UK Biobank and Scottish Early Rheumatoid Arthritis (SERA) data showed that people with rheumatoid arthritis and two or more comorbidities experienced significantly higher rates and longer durations of hospitalisation, compared to those with rheumatoid arthritis alone.[102] Beyond health burden, social stigma and isolation are common; Versus Arthritis (now Arthritis UK) reported that people with arthritis, in general, felt that their condition was an "unseen burden" due to constant pain, and the feeling of being judged by others.[11,47] Rheumatoid arthritis also imposes a considerable economic toll, with total annual costs to the UK economy, including both direct healthcare expenses and indirect costs such as work-related disability and lost productivity, estimated between £3.8 and £4.8 billion, of which around £560 million is borne by the NHS.[103]

Rheumatoid arthritis substantially impacts employment, with work loss affecting a majority of patients over time. A systematic review reported that a median of 66% of employed rheumatoid arthritis patients experienced work loss within a 12-month period.[104] A more recent systematic review found that employment rates decline from 79% at disease onset to 40% at follow-up, with factors such as younger age, male sex,

higher education, and lower disease activity predicting sustained employment.[105] These findings highlight the significant economic and social burden of rheumatoid arthritis and the need for interventions to maintain work capacity.

1.3.7 Treatment

The treatment of rheumatoid arthritis has evolved to focus on early diagnosis and timely intervention to prevent irreversible joint damage and systemic complications.[106-108] The primary goal of treatment is the "treat to target" approach, which aims to achieve clinical remission (absence of inflammation, reduced functional impairment, and minimal joint damage) or low disease activity if clinical remission cannot be achieved.[106-108] As with osteoarthritis, treatment strategies incorporate both pharmacological and non-pharmacological interventions, guided by international and national clinical practice guidelines, including those from the ACR, EULAR, and NICE.[106-108]

Pharmacological treatment is categorised into symptomatic treatment and disease-modifying treatment.[94,95] Symptomatic relief is provided by NSAIDs and GCs, which provide short-term relief but do not alter disease progression.[106,107] Disease-modifying anti-rheumatic drugs (DMARDs), administered orally, subcutaneously, or intravenously, that suppress

autoimmune activity and aim to prevent long-term joint deterioration.[106,107] Methotrexate (MTX), a conventional synthetic DMARD (csDMARD), is the first-line treatment choice due to its strong efficacy, safety profile, flexible administration, and low cost.[106,107] The 2021 ACR guideline strongly recommends MTX monotherapy over other csDMARDs (e.g., sulfasalazine, hydroxychloroquine) or biologic DMARDs (bDMARDs) for treatment-naive patients with moderate-to-high disease activity.[106] A systematic review of clinical trials found that MTX offers favourable efficacy and the safest profile among csDMARDs.[109] Despite its effectiveness, adverse effects, including gastrointestinal distress, hepatotoxicity, haematologic changes, and pulmonary toxicity (e.g., pneumonitis, fibrosis), can occur.[110] For patients with inadequate response or intolerance to csDMARDs, escalation to bDMARDs or targeted synthetic DMARDs (tsDMARDs), such as Janus kinase (JAK) inhibitors, is recommended.[106] Biological DMARDs (e.g., infliximab) are genetically engineered protein molecules that selectively target structures of the immune system.[111] While effective in reducing disease activity, they are associated with increased risk of bacterial and opportunistic infections, requiring regular monitoring.[111] JAK inhibitors are reserved for more severe disease and have risks such as gastrointestinal, renal, and cardiac effects.[106,107]

Non-pharmacological treatment plays an important role as an adjunct to pharmacological treatment.[106,107] Recommended interventions include physical activity (e.g., brisk walking, resistance training), physiotherapy, occupational therapy, and psychological support.[106,107] A systematic review and meta-analysis including 16 lifestyle physical activity interventions (e.g., patient education, physical exercises) led to increased physical activity and improvements in health outcomes of rheumatoid arthritis.[112] Mind-body therapies (e.g., yoga, Tai Chi) are conditionally recommended, particularly as complementary interventions in patients seeking holistic care.[113,114]

Surgical treatment, such as joint replacement, is considered only for advanced cases characterised by extensive joint destruction and significant functional impairment.[107] It is considered only when pharmacological and non-pharmacological approaches have failed to achieve adequate disease control.[107]

In the UK, rheumatoid arthritis treatment is guided by the NICE guideline, which recommends a step-wise, individualised approach.[108] The treatment typically begins with csDMARD monotherapy, usually methotrexate, with

dose adjustment based on response.[108] In cases of inadequate response, additional csDMARDs may be introduced in a step-up strategy.[108] GCs are used to manage acute flares short-term, and NSAIDs may be used for symptom control, but their use should be tailored to an individual's age, comorbidities and risk factors.[108] Non-pharmacological interventions such as physiotherapy, hand exercises, stress management, and dietary changes are recommended for use as complementary treatments alongside pharmacological treatment.[108] The guideline also emphasises the importance of access to a multidisciplinary team to provide comprehensive care, involving regular assessments of pain, fatigue, mental health, and overall quality of life.[108]

A key recommendation common to UK and international guidelines is the development of an individualised treatment plan tailored to patient symptoms, comorbidities, and personal goals, integrating both pharmacological and non-pharmacological treatments to optimise outcomes.[106-108]

Non-pharmacological strategies and multidisciplinary support not only complement pharmacological treatment but also empower patients through education and self-management.[106-108] In line with current UK guidance, self-management and patient education are central to rheumatoid arthritis care. The

British Society for Rheumatology (BSR) encourages patient-initiated review and follow-up, supported by remote monitoring, advice lines, and digital tools, enabling patients to take control of their care while reducing routine clinic appointments.[115] Remote monitoring can include online symptom trackers, patient-reported outcome measures, and app-based tools. Similarly, NICE emphasises that adults with rheumatoid arthritis should get opportunities to participate in educational activities that support self-management, improve understanding of their condition, and enhance their ability to manage pain, fatigue, and flares.[116] Together, these approaches promote patient ownership, informed decision-making, and improved quality of life, complementing pharmacological and non-pharmacological treatment strategies. The following flowchart (Figure 4) illustrates the typical patient journey in rheumatoid arthritis, highlighting the role of primary care in early recognition, referral to a rheumatologist, diagnosis, treatment initiation, and ongoing self-management.

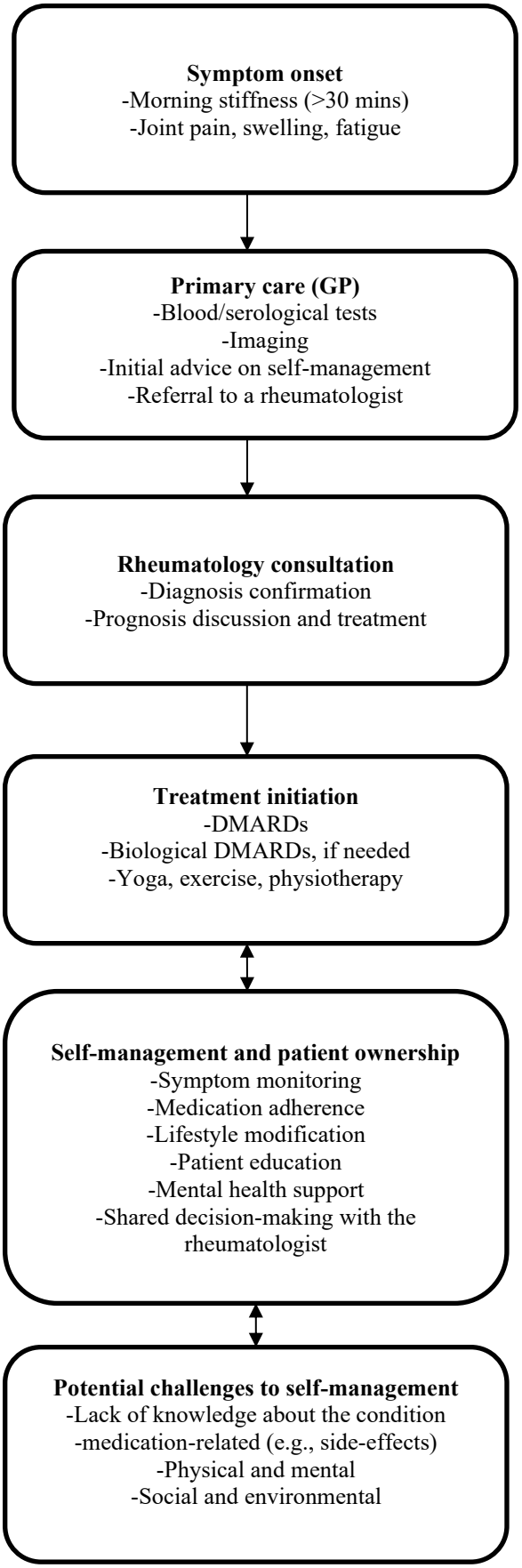


Figure 4 Typical patient journey in the rheumatoid arthritis care pathway.

1.3.8 Clinical outcomes and their measurement

Rheumatoid arthritis is associated with key clinical outcomes, including increased pain, stiffness, and disease activity scores, reduced physical function, and poor health-related quality of life.[106] A primary goal of rheumatoid arthritis treatment (as described in 1.3.7) is to achieve clinical remission.[106-108] Remission is associated with improved physical function, slowed joint damage progression, and an enhanced overall quality of life.[106-108] The ACR/EULAR remission criteria define remission based on a combination of clinical and laboratory parameters.[106,107] Alternatively, composite indices such as the Disease Activity Score 28 (DAS28) are also used, with a score of <2.6 indicating remission.[117,118] It is one of the most commonly used assessments of disease activity in rheumatoid arthritis clinical trials.[117]

The ACR Rheumatoid Arthritis Disease Activity Measure Workgroup conducted a systematic review of all rheumatoid arthritis disease activity measurement instruments and recommends several PROMs for regular use, including DAS28, the Clinical Disease Activity Index (CDAI), and the Simplified Disease Activity Index (SDAI).[119] These PROMs and indices are used in both research and clinical settings for consistent and objective evaluation of disease activity and treatment outcomes.[117,118] Standardised outcome measurement

scales not only help monitor disease progression but also enable comparisons between different treatment options.[117] Table 4 summarises commonly used outcome measurement scales for rheumatoid arthritis, detailing scoring and interpretation.

Table 4 Commonly used outcome measurement scales in rheumatoid arthritis, including scoring and interpretation.

Outcome	Scale	Description	Scoring and interpretation
Disease activity score	Clinical Disease Activity Index (CDAI)[120]	• To measure disease activity. • Consists of the number of tender joints (0–28) (clinician-reported), number of swollen joints (0–28) (clinician-reported), patient global disease activity (self-reported), and physician global assessment of the disease activity (clinician-reported).	• Score ranges from 0 to 76. • Remission: ≤2.8 • Low disease activity: >2.8 to ≤10 • Moderate disease activity: >10 to ≤22 • High disease activity: >22.1
	Disease Activity Score in 28 joints (DAS28) [DAS28 – Erythrocyte sedimentation rate (ESR) and DAS28 - C-reactive protein (CRP)][118,121]	• To measure disease activity. • Consists of the number of tender joints (0–28) (clinician-reported), number of swollen joints (0–28) (clinician-reported), patient global health on a Visual Analogue Scale (VAS) of 0–10 (self-reported), and measurement of acute phase reactants (either ESR or CRP) (lab-based). • DAS28-CRP is a modification of DAS28-ESR, with CRP responding more rapidly to inflammation changes.	• Score ranges from 0 to 9.4. • Remission: <2.6 • Low disease activity: ≥2.6 to ≤3.2 • Moderate disease activity: >3.2 to ≤5.1 • High disease activity: >5.1
Flare	FLARE-RA[122]	• To detect flare between visits to the physician. • Includes 13 domains - joint swelling, joint pain, night awakening, pain killer intake (both clinician- and self-reported), fatigue, impossibility to do a thing, need for help, withdrawal from social activities, bad mood, and irritability (self-reported), or morning stiffness, daily dose of steroids, patient's global assessment (clinician-reported)	• For each statement, the respondent indicates agreement, using a numerical rating scale from 0 (completely untrue) to 10 (absolutely true). • The total FLARE-RA score is the mean of the scores for the 13 items.

Pain	Simple Descriptive Pain Intensity Scale (SDPIS)[68]	• To measure pain intensity. • Self-reported.	• Score ranges from 0 (no pain) to 5 (worst possible pain).
	Visual Analogue Scale (VAS)[69]	• To measure pain intensity. • A single item scale with a 10 cm ruler used to mark pain intensity. • Self-reported.	• Score ranges from 0 (no pain) to 100 (worst possible pain). • Score is determined by measuring the distance (in millimetres or centimetres) from the zero point to the patient's mark on the scale.
	Numeric Rating Scale (NRS)[69]	• A modified version of VAS consisting of a segmented numerical scale with 11 points. • Self-reported. •	• Score ranges from 0 (no pain) to 10 (worst possible pain).
Function	Health Assessment Questionnaire Disability Index (HAQ-DI)[70]	• To measure functional ability in 20 activities of daily living. • Comprises 20 items across 8 domains, including dressing, standing, eating, walking, hygiene, reaching, gripping, and usual activities. • Self-reported.	• Each domain has a set of questions scored from 0 (no disability) to 3 (unable to perform activity). • Total score is the mean of the 8 domain scores, classified into: • 0–1: mild to moderate disability • 1–2: moderate to severe disability • 2–3: severe to very severe disability.
	Arthritis Impact Measurement Scales (AIMS) expanded and revised to AIMS2[71]	Consists of 78 items capturing information in 12 areas of health (mobility level, walking and bending, hand and finger function, arm function, self-care tasks, household tasks, social activity, support from family and friends, pain, work, level of tension, mood). • These 12 areas are aggregated into five major dimensions (physical functioning, social interaction, pain, work and affect).	• Score ranges from 0 to 10 (10 being worst possible health).

		• Self-reported.	
	Short Form-36 Health Survey (SF-36)[69]	• To measure overall health status. • Consists of 36 items across 8 domains, including vitality, physical functioning, bodily pain, general health, physical role functioning, emotional role functioning, social role functioning, and mental health. • Self-reported.	• Each domain is scored separately from 0 (worst possible health) to 100 (best possible health). • Scores are weighted sums of items in each domain.

1.4 Distinguishing features of osteoarthritis and rheumatoid arthritis

This brief section compares osteoarthritis and rheumatoid arthritis to highlight their shared symptoms but differing causes, disease mechanisms, and treatment approaches. Overall, osteoarthritis and rheumatoid arthritis are both prevalent musculoskeletal conditions with overlapping symptoms, such as joint pain, swelling, and stiffness, which can make early diagnosis of both conditions difficult.[16,77] However, they differ fundamentally in their pathophysiology, making accurate differentiation crucial for effective treatment.[16,77] Table 5 summarises key clinical and pathological distinctions, which are particularly important in the early stages when features may overlap. This comparison underscores the need for complementary interventions, such as yoga, that can be flexibly adapted to distinct types of arthritis. The differences between these two conditions provide a useful framework for understanding how yoga might be beneficial in both contexts.

Table 5 Key differences between osteoarthritis and rheumatoid arthritis.

Distinguishing feature	**Osteoarthritis**	**Rheumatoid arthritis**
Pattern of joint involvement	Typically asymmetrical	Usually symmetrical
Pathological presentation	Localised to joints	Systemic condition
Commonly affected joints	Larger weight-bearing joints (e.g., knees, hips, spine)	Smaller joints (e.g., hands, wrists, feet)
Underlying cause	Wear and tear of joints	Autoimmune inflammatory response
Morning stiffness	Typically reduces within 20-30 minutes	Persists for ≥30 minutes

The following section explores yoga's origins, philosophy, and its emerging therapeutic role in arthritis treatment.

1.5 Yoga as an approach to managing arthritis symptoms

1.5.1 Origin and philosophy of yoga

Yoga is an ancient mind-body discipline that originated in the Indian subcontinent over 5,000 years ago.[123] Its precise origins are difficult to determine due to its evolution over generations through oral teachings, philosophical discourse, and written texts.[123,124] The earliest textual references to yoga can be traced back to the Vedas, particularly the Rigveda (circa 1500-200 before common era (BCE)), which form the foundational scriptures of Hinduism.[125] One of the most influential classical texts on yoga is the *Yoga Sutras* (circa 400 BCE), written by sage Patanjali, also known as "the father of modern yoga", which articulates the theoretical and practical aspects of yoga.[126,127] The word "yoga" is derived from the Sanskrit word "*yuj*," meaning "unity" or "oneness", symbolising the integration of body, mind, and spirit.[127]

Philosophically, yoga seeks to unite an individual's consciousness with the universal consciousness.[126,127] Traditionally, yoga emerged within the broader context of Hindu philosophy as a discipline aimed at achieving a balance between physical, mental, and spiritual dimensions of

health.[127] According to Patanjali, the practice of Raja yoga, also known as Ashtanga (eight limbs) yoga, consists of eight interconnected practices, all equally important to achieve inner transformation and holistic well-being.[126] The *Yoga Sutras* outline this structured framework of eightfold key components, as described in Table 6.[124,126]

Table 6 Eight limbs or practices of yoga and their meanings.[124,126]

Yama (restraint)	Ethical disciplines for social conduct, including non- violence (*ahimsa*), truthfulness (*satya*), non-stealing (*asteya*), celibacy or control of energy (*brahmacharya*), and non-possessiveness (*aparigraha*).
Niyama (observance of austerity)	Ethical disciplines for self-regulation, including cleanliness (*sauca*), contentment (*santosa*), self- discipline (*tapas*), self-study (*svadhyaya*), and surrender to a higher power (*ishvara pranidhana*).
Asana (yogic poses)	Physical postures to prepare the body and mind for meditation and cultivate physical awareness.
Pranayama (breathing practices)	Specific techniques to regulate breath and control life force (*prana*), thereby calming the mind and supporting focus.
Pratyahara (restraining of sense organs)	The inward withdrawal of the senses to reduce external distractions, enabling a calm mind and promoting introspection.
Dharana (contemplation)	Focused attention on a single object, sound, or concept to discipline the mind and reduce distractions.
Dhyana (meditation)	Process of reducing the wandering of the mind to maintain focus towards an object of attention, promoting mental clarity and calmness.
Samadhi (deep meditation)	A state of profound meditative absorption, including silencing all levels of the mind and unity with the object of focus, which represents the culmination of yoga practice.

Over time, the different philosophies, traditions, and lineages of spiritual masters (gurus) and their disciples have given rise to different schools or styles of yoga.[127,128] Each school has its own approach with emphasis on different aspects of practice, but shares the common goal of achieving the ultimate aim of yoga.[127,128] These include Raja Yoga, Hatha Yoga, Karma Yoga, Bhakti Yoga, Jnana Yoga, Mantra Yoga, and Kundalini Yoga, which are described in Table 7:[127,129]

Table 7 Classical schools of yoga as described in traditional texts.[127-129]

Raja yoga	Emphasises mental discipline, meditation, and inner awareness; also called classical or Patanjali yoga.
Hatha yoga	The most widely practised form today, focused on yogic poses and breathing practices to prepare the body and mind for meditation. Modern styles such as Iyengar, Ashtanga, Bikram, and Viniyoga are derived from this tradition.
Karma yoga	The path of selfless action, encouraging work without attachment to outcomes.
Bhakti yoga	The path of devotion, to cultivate love and surrender through worship and rituals.
Jnana yoga	The path of knowledge and self-inquiry, using philosophical reflection to overcome ignorance.
Mantra yoga	Utilises repetition of sacred sounds (*mantras*) to achieve mental focus and spiritual alignment.
Kundalini yoga	Aims to awaken dormant spiritual energy (*Kundalini shakti* - a spiritual force believed to reside at the base of the spine) through yogic poses, breathing practices, meditation and relaxation practices, and chanting.

Although these yoga styles vary in practice, evidence suggests that no particular style is consistently more effective than others in clinical outcomes.[130] A systematic review of 312 RCTs conducted across 23 countries, including 22,548 participants, investigated the effects of yoga interventions across a wide range of populations and health conditions.[130] The RCTs included 52 distinct yoga styles, most frequently Hatha, Iyengar, and Integrated Approach to Yoga Therapy, and recruited both clinical (e.g., musculoskeletal, cardiovascular, and mental health conditions) and non-clinical (healthy or general population) participants. Across these trials, yoga interventions were typically compared with usual care, wait-list, or other active interventions, with outcomes such as pain, physical function, psychological well-being, or quality of life. Over 90% of randomised controlled trials (RCTs) on yoga report positive results, regardless of the specific style used.[130] Thus, the choice of a yoga style in both research and practice is often based on individual preferences and availability.[130] Notably, Hatha and Iyengar yoga are among the most commonly studied and practised forms in the current times.[127,129,130]

As yoga spread beyond the Indian subcontinent, its philosophy and practices adapted to new cultural contexts,

particularly in Western societies, as discussed in the following section.

1.5.2 Historical origins and evolution of yoga practice in Western cultures

In the yogic tradition, the origin of yoga is attributed to Lord Shiva, the first yogi (*Adiyogi*) and the first guru (*Adiguru*).[123,126] Several thousand years ago, he is believed to have transmitted the profound science of yoga to his seven disciples or *saptarishis* (seven sages), who then spread this knowledge across different parts of the world.[123,126] Among them, Sage Agastya played a pivotal role in shaping the yogic culture throughout the Indian subcontinent.[123,126] The transmission of yoga through various sages and spiritual traditions was later codified into a formal system by Patanjali.[126] Later, many spiritual teachers and scholars have contributed immensely to the preservation and dissemination of yoga practice across the world.[123]

Whilst the philosophy of yoga is widely understood and practised in the Indian subcontinent with a focus on physical, mental, and spiritual development, its adoption in the West has largely emphasised asana (yogic poses), i.e., the physical aspects.[131] This difference reflects broader cultural and

historical differences in the understanding and practice of yoga across regions.[131]

Yoga was introduced to the West in the late 19th and early 20th centuries by influential Indian figures such as Swami Vivekananda and Yogini Sunita, who played defining roles in promoting yoga in the United States of America (USA) and the UK.[131-134] During this period, yoga became particularly popular among women, partly because it aligned with the then-popular physical exercise systems such as Swedish and Danish gymnastics.[133] In the UK, women began practising yoga for various reasons, with physical health and mental wellness being central motivations.[133]

Throughout the 20th century, yoga's popularity in the West grew steadily, supported by the translation of core yogic texts and the emergence of new yoga styles.[131,133,134] Notably, the 1980s witnessed the rise of dynamic styles such as Ashtanga and Vinyasa yoga, while the 1990s marked the proliferation of commercial studios offering a diverse range of yoga styles.[134] In the UK, this evolution was strongly influenced by figures such as BKS Iyengar and K. Pattabhi Jois.[134,135] Their trainees and followers significantly influenced an increase in yoga teachers in the UK.[134] Professional organisations such as

the British Wheel of Yoga (BWY) now offer formal training, insurance, and accreditation.[133]

In many Western contexts, it is still primarily practised for its physical benefits, such as improving strength, flexibility, and physical appearance.[135] However, there is emerging evidence that people practising yoga often begin to explore deeper philosophical and spiritual dimensions as their practice progresses over time.[136-138] This shift reflects a broader recognition of yoga's holistic benefits, even within Western societies, including in the UK.[136-138]

Along with the historical and cultural evolution of yoga, it is also essential to explore the current landscape of yoga practice, both globally and in the UK, as explored in the next section.

1.5.3 Global overview of yoga practice

Yoga has seen a remarkable rise in global popularity over the past several decades, with an estimated 300 million people practising it worldwide.[139] The reasons for its popularity include its physical and psychological health benefits and its convenience of being adapted to various levels of intensity, delivery formats, and cultural contexts.[137] Previous surveys, conducted in India, Australia, and the USA, show consistent

patterns of yoga practice, with higher prevalence among women, higher levels of education, and those with higher incomes.[140-142]

In India, a nationwide cluster sample survey conducted in 2017 (n = 162,330) found that 11.8% of the population practised yoga, with comparable rates across gender, urban versus rural settings, and among older adults (60-79 years).[140] Although 92.6% of participants acknowledged yoga's health benefits, actual yoga practice remained low, highlighting a knowledge-practice gap.[140] The widespread awareness in India may be attributed to yoga's cultural origins, its widespread promotion by public figures, including the Prime Minister, as well as the influence of spiritual leaders on media platforms.[123] More recent data from 2022-2023 indicate a substantial rise in yoga participation, with 31% of women and 22% of men practising yoga.[139]

A survey conducted in 2016 in Australia, younger women had a higher prevalence of yoga or meditation use (11.1%), while older women were more regular with their yoga practice (9.2%), although the lack of distinction between yoga and meditation limited interpretations.[141]

Using cross-sectional data from the 2012 National Health Interview Survey, yoga use in the USA nearly tripled from 2002 to 2017, with 13.2% having ever practised and 8.9% in the past year, mostly non-Hispanic white women with higher education.[142] Commonly reported reasons included back pain (19.7%), stress (6.4%), and arthritis (6.4%), and breathing practices were the most frequently used component.[142]

Nonetheless, participation in yoga in the West remains highly gendered. For instance, in the USA, between 2012 and 2022, male yoga participation grew from 4 million to 14 million.[139] Similar trends are seen in the UK and Spain, where roughly three times as many women practise yoga compared to men.[139] By contrast, India's most recent data show relatively higher engagement in yoga among men, when compared with data from the rest of the world.[139]

While these figures illustrate yoga's global reach, the available evidence largely represents a small number of countries, particularly high-income and yoga-origin nations. Consequently, estimates of global participation may not fully capture patterns in low- and middle-income countries, where large-scale surveys are limited. Future cross-national research would be valuable for developing a more representative understanding of global yoga practice.

To support the global expansion of traditional health practices, the WHO launched its Traditional Medicine Strategy 2014-2023, aiming to improve the quality, safety, and effectiveness of traditional and complementary medicine.[143] As part of this effort, and in collaboration with the Ministry of AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homoeopathy) of the Indian Government, WHO developed the mYoga app, which enables global users to access standardised yoga practices via smartphones.[123,143] The Ministry of AYUSH in India also promotes yoga through research funding, the establishment of educational institutions, and international collaborations.[123] It recognises yoga's potential in preventing and managing non-communicable diseases, and enhancing overall health and well-being.[123]

1.5.3.1 Yoga delivery and practice in the UK

In the UK, approximately 2.5 million people were reported to be practising some form of yoga in 2004, and the popularity of yoga has been rising ever since.[136,144,145] In the UK, yoga providers include both yoga teachers and yoga therapists. The majority are yoga teachers, estimated at over 10,000[146], and only around 150 are yoga therapists, that is yoga teachers with additional specialised training to adapt yoga therapeutically

for people with specific health conditions[147], who are not required to hold formal health professional registration in the UK.

A recent cross-sectional survey of UK-based yoga providers found that yoga sessions are widely available and predominantly delivered by women.[148] These sessions typically focus on physical poses with limited inclusion of breathing practices, and meditation and relaxation practices.[148] This emphasis on physical postures over breathing practices and meditation and relaxation practices reflects the general Western adaptation of yoga, which tends to prioritise fitness and physical health outcomes. Different styles of yoga were reported in this survey, with Hatha and Iyengar being the most commonly delivered styles.[148]

An analysis of the Health Survey for England (2006-2008) found that 1.11% (95% CI 0.95% to 1.28%) of respondents reported practising yoga within the past four weeks, with higher rates among women, individuals with degree-level education, and those in non-manual occupations.[145] However, this may underestimate actual prevalence, as respondents may not have recognised yoga as a form of physical activity in a survey focused on sports and exercise.[145]

1.5.3.2 Use of yoga for arthritis and health conditions in the UK

Notably, there is a lack of detailed information on yoga practice, specifically among people with arthritis in the UK. However, a comprehensive survey reported that 16% of the respondents (n = 2434) began practising yoga to address specific physical or mental health issues, with particular emphasis on musculoskeletal conditions, including arthritis (n = 201).[136] The most popular venues for yoga practice were yoga studios (57.5%), community halls (38%) and gyms (25.1%), with 20.7% practising at home using online resources or DVDs.122 Hatha (28%) and Iyengar (25.3%) were the most popular yoga styles, followed by Vinyasa flow (14.8%) and Ashtanga (7.2%).[136] Physical postures were present in 65% of sessions, while fewer included breathing (13%), relaxation (12%), and meditation (9%).[136]

Given these patterns, most individuals with arthritis in the UK are likely to attend general yoga classes led by yoga teachers who may not have specialised knowledge of the condition. This highlights a potential gap in access to tailored therapeutic yoga interventions for this population.

1.5.4 Potential mechanisms of yoga's effects in arthritis

Yoga may influence outcomes in arthritis through a combination of physical, psychological, and social factors, aligning closely with the Biopsychosocial model of health (Figure 5).[149] This model recognises the dynamic interactions among biological, physical, psychological, and social factors that influence pain, function, and overall well-being, which may be helpful in chronic conditions such as arthritis.[149-151] Yoga practice incorporates this holistic approach by addressing the person rather than just the condition, thereby supporting physical recovery, enhancing mental health, and fostering social interaction.[151]

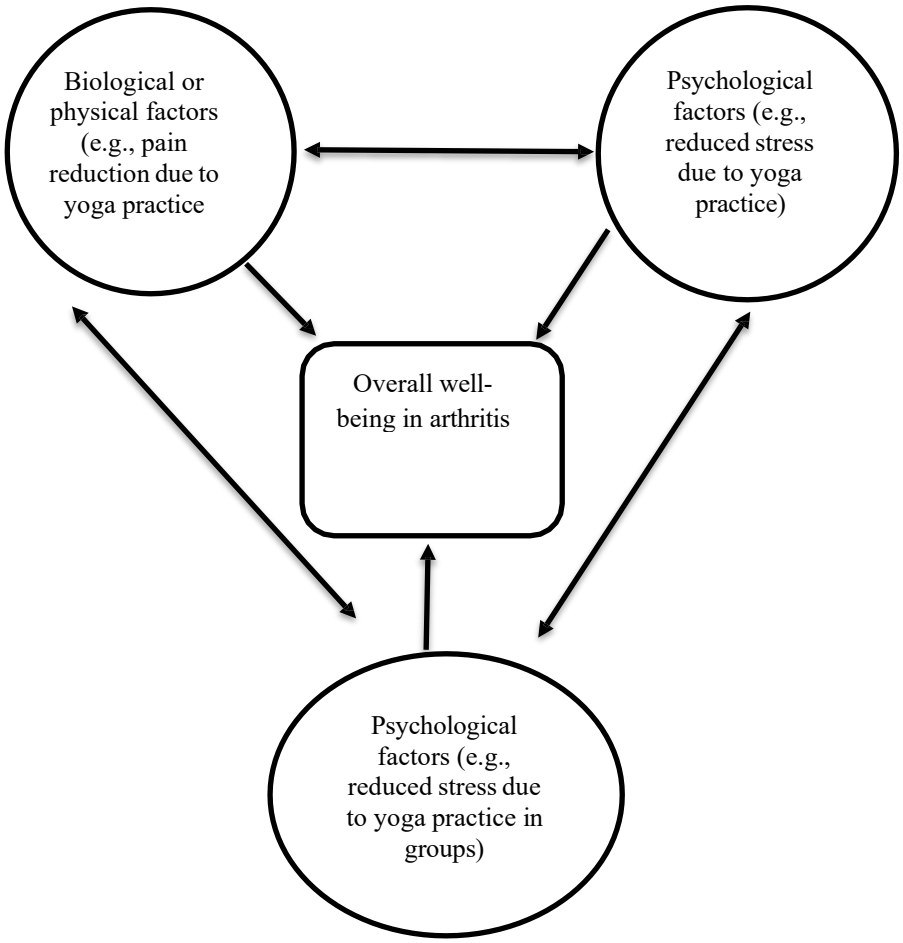


Figure 5 Yoga's alignment with the Biopsychosocial model and how yoga may enhance overall well-being in arthritis.
Source: Based on the model from Engel (1977).[149]

Yoga practice typically begins with slow and controlled movement sequences to increase blood flow and warm up muscles.[151] This is followed by holding certain yogic poses, involving flexion, extension, adduction, abduction and rotation, that engage muscles through isometric contraction.[151,152] These movements enhance joint flexibility, strengthen major muscle groups such as the quadriceps and hamstrings, and improve balance, coordination, and overall physical function.[153] These effects may lead to reductions in

pain and stiffness, and improvements in mobility and daily functioning, particularly beneficial in osteoarthritis.[152-154] Additionally, improved muscle support around joints may lower joint loading and promote better posture.[153]

Beyond physical benefits, yoga incorporates breathing practices and meditation and relaxation practices, a combination which may alleviate psychological symptoms such as stress, anxiety, and depression, which are highly prevalent in arthritis, especially osteoarthritis and rheumatoid arthritis.[155-159] Chronic pain can impair emotional regulation, contributing to a cycle of increased pain perception and adding to the mental stress.[160] In rheumatoid arthritis, mental stress may exacerbate inflammation by increasing sympathetic nervous system activity and elevating the levels of inflammatory cytokines.[161] Breathing practices in yoga may help restore autonomic balance by enhancing parasympathetic activity, counteracting stress responses, and potentially reducing systemic inflammation, leading to calmness and reduced stress.[155,156] Regular yoga practice has been shown to reduce cortisol levels, the body's primary stress hormone, thus mitigating the harmful effects of chronic stress on physical and mental health.[162]

In addition to the physical and psychological effects, the lifestyle component of yoga encourages living mindfully,

including healthier dietary habits.[163] These lifestyle changes may contribute to better weight management, helping to prevent obesity, a critical risk factor in osteoarthritis and rheumatoid arthritis.[16,77] Yoga may also help develop a mindset in people to abstain from smoking and alcohol dependence, which are often discouraged in a yogic lifestyle and may contribute to better long-term health.[164,165] A randomised controlled study (RCT) suggests that Hatha yoga may be an adjunctive treatment for smoking cessation in adults.[164] Given that smoking is a significant risk factor for rheumatoid arthritis[77], yoga's potential to reduce smoking may contribute to improved outcomes in this population. Another RCT found yoga to be a feasible and well-accepted adjunct treatment for alcohol dependence, which may also positively affect arthritis outcomes.[165] Also, as feelings of loneliness and isolation are common among people with arthritis, practising yoga can enhance social well-being by creating opportunities for social connection and a sense of community.[166,167]

Collectively, these potential mechanisms suggest that yoga can be a feasible adjunctive approach that may provide overall health benefits, improving physical function, psychological well-being, and lifestyle behaviours for people

with arthritis, particularly those with osteoarthritis and rheumatoid arthritis.

1.5.5 The effectiveness of yoga for arthritis

Although no systematic review to date has evaluated the effectiveness of yoga for arthritis as a broad condition, a 2011 scoping review included both randomised and non-randomised studies published between 1980 and 2010.[168] Of the nine included studies, five focused on rheumatoid arthritis, two on osteoarthritis, and two included patients with either condition or an unspecified type of arthritis.[168] The review found that yoga was associated with reductions in tender and swollen joints, decreased pain, and improved physical function. No adverse events were reported.[168] However, substantial heterogeneity in interventions, study designs, and diagnostic classifications limited the generalisability of findings and underscored the need for methodologically rigorous RCTs to evaluate the effectiveness of yoga in arthritis treatment.[168]

1.5.5.1 Effectiveness of yoga for osteoarthritis: evidence from systematic reviews and meta-analyses

To date, several systematic reviews and meta-analyses on the effectiveness of yoga interventions have reported beneficial effects on osteoarthritis outcomes such as pain relief and

functional improvement.[169-176] However, many reviews included heterogeneous interventions, variable study designs, and often combined yoga with other mind-body practices, limiting the specificity and applicability of their findings, highlighting the need for a systematic review focusing exclusively on well-defined yoga interventions for osteoarthritis. These reviews primarily included RCTs[169-176], though one also included non-randomised study designs[174]. Reviews generally compared yoga intervention with no treatment, usual care (including both pharmacological and non-pharmacological interventions), or other non-pharmacological interventions alone.[169-176] Of the eight systematic reviews, four included a meta-analysis.[172-174,176] The most recent systematic review and meta-analysis, focusing on knee osteoarthritis, included eight RCTs on yoga with a total of 756 patients.[176] It found significant effects of yoga in alleviating pain (standardised mean difference (SMD) -0.92; 95% CI -1.64 to - 0.20) and physical function (-0.53; -0.89 to -0.17), compared to non-pharmacological interventions.[176] Notably, none of the reviews reported any serious or non-serious adverse events related to yoga interventions.[169-176]

1.5.5.2 Effectiveness of yoga for rheumatoid arthritis: evidence from systematic reviews and meta-analyses

Some systematic reviews that included randomised and non-randomised studies have reported beneficial effects of yoga interventions on one or more outcomes in patients with rheumatoid arthritis, such as lower disease activity scores, pain relief, and functional improvement.[169,170,177-181] Nevertheless, these reviews often included studies with mixed populations, varied intervention protocols, and limited methodological rigour, underscoring the need for a focused systematic review including yoga interventions specifically for rheumatoid arthritis. In these reviews, yoga interventions were generally compared with no treatment, usual care (including both pharmacological and non-pharmacological interventions), or other non-pharmacological interventions alone.[169,170,177-181] Three reviews also included a meta-analysis.[179-181] The most recent systematic review and meta-analysis, which included 10 studies (both randomised and non-randomised) focusing on only yoga involving 840 patients with rheumatoid arthritis showed that yoga in addition to standard medical treatment, significantly lowered disease activity score (four RCTs; SMD -0.38; 95% CI: -0.71 to -0.06) and improved physical function (five RCTs; -0.32; -0.58 to -0.05) compared to conventional medicine alone.[181]

No reviews reported serious or non-serious adverse events related to yoga.[169,170,177-181]

1.5.6 Gaps and limitations in previous systematic reviews and RCTs

Several systematic reviews on osteoarthritis and rheumatoid arthritis have included studies with participants who had various other musculoskeletal conditions beyond osteoarthritis and rheumatoid arthritis, such as low back pain[170,179,180], sarcopenia and neck pain[175], fibromyalgia[170,178,180], kyphosis[170,180], and muscle soreness[179]. Some reviews also assessed yoga as a part of broader mind-body interventions such as mindfulness-based stress reduction, progressive muscle relaxation, Tai Chi, and Qigong.[174,177] While these broader reviews provide useful context on complementary treatments, they do not focus exclusively on yoga, which limits the specificity of their conclusions regarding the effectiveness of yoga for osteoarthritis and rheumatoid arthritis. More recent yoga-specific systematic reviews have addressed some of these limitations by focusing solely on yoga interventions and refining participant criteria to include patients with only osteoarthritis or rheumatoid arthritis. However, some notable issues remain. For example, search strategies in many of these reviews were limited in scope, typically including a smaller

number of databases, imposing date or language restrictions, and mainly focused only on narrow definitions of yoga that emphasised yogic poses and breathing practices while neglecting other important aspects of yoga philosophy and practice. Moreover, not all relevant search terms for osteoarthritis and rheumatoid arthritis were employed, which may have led to the omission of relevant studies.

Importantly, some reviews lacked clarity in their inclusion criteria for study design, and not all included trials met the rigorous standards of RCTs as commonly defined in evidence-based practice. This inconsistency may have compromised the internal validity and comparability of findings across reviews. Many included studies were of poor methodological quality and had heterogeneity in the key components, i.e., content, structure, and delivery characteristics of yoga interventions, making it challenging to identify a single effective yoga intervention and replicate successful interventions for each condition. Moreover, reporting of adverse events was missing.

Although these reviews have contributed to the evidence base by narrowing the focus on yoga, they provide weak but promising evidence that yoga could be a beneficial addition to osteoarthritis and rheumatoid arthritis treatment. A significant

gap remains in synthesising the key components of yoga interventions that contribute to their effectiveness. This thesis addresses these gaps by conducting methodologically rigorous systematic reviews that: (i) strictly include well-defined RCTs, (ii) apply comprehensive and inclusive search strategies, (iii) focus exclusively on yoga interventions, and (iv) synthesise the content, structure, and delivery characteristics of effective yoga interventions for osteoarthritis and rheumatoid arthritis treatment.

The following section articulates the rationale for undertaking the current research. It highlights inconsistencies in previous evidence on yoga for arthritis and the lack of UK-specific studies. It explains how addressing these gaps is crucial for developing evidence-based recommendations for integrating yoga as a complementary approach into arthritis treatment.

1.6 Rationale for the thesis

Several global systematic reviews of RCTs suggest that yoga, when used as a complementary intervention, may have beneficial effects on arthritis outcomes, including pain reduction and improved physical function in both osteoarthritis and rheumatoid arthritis, as well as reductions in disease activity scores in rheumatoid arthritis.[169-181] However, the term “yoga” encompasses a wide range of practices, and

the RCTs included in these reviews vary in their key features, including content, structure, and delivery characteristics. Although existing reviews have described these variations, none have synthesised these components of effective yoga interventions that may be effective in arthritis treatment. Addressing this gap is essential to guide future development and implementation of evidence-based yoga interventions. This need is particularly relevant in the UK, where osteoarthritis and rheumatoid arthritis are the most prevalent types of arthritis.

Yoga is widely practised in the UK and has been reported by people attending yoga sessions as helpful for alleviating arthritis symptoms.[136] However, there is limited qualitative research exploring the insights of people with arthritis practising yoga, both globally[182-184] and specifically within the UK[184]. While some global studies have identified the factors that hinder (barriers) and encourage (facilitators) yoga practice among this population, these findings have not been synthesised.[182-184] Further, no prior study has explored insights from UK-based yoga providers on what they know about the condition, what experiences they have had in delivering yoga to people with arthritis, how they perceive their role in managing arthritis and what further training they may require. Yoga providers play a pivotal role in supporting

people with arthritis, and their insights can help identify challenges in delivering yoga and suggest context-specific recommendations for integrating yoga into arthritis treatment in the UK.

This thesis addresses these gaps in evidence through four interconnected studies: two systematic reviews synthesising the key features of effective yoga interventions used as a complementary approach to osteoarthritis and rheumatoid arthritis treatment; a systematic review of barriers and facilitators to yoga practice among people with arthritis; and a qualitative study exploring UK yoga providers' clinical knowledge, experiences, and perceptions of arthritis treatment.

1.7 Thesis aim and objectives

This final section summarises the overall aim and specific objectives of the thesis. It clarifies how the research is structured to address identified gaps through a combination of systematic reviews and a qualitative study, each contributing unique insights into the potential role of yoga in arthritis treatment. The overall aim of the thesis was to critically examine the evidence on the role of yoga as a complementary intervention for arthritis, focusing on its potential within the UK healthcare system.

The specific objectives were:

1. To conduct a systematic review synthesising the key features of effective yoga interventions used as a complementary approach in osteoarthritis treatment (Chapter Two).
2. To conduct a systematic review synthesising the key features of effective yoga interventions in addition to standard medical treatment for rheumatoid arthritis (Chapter Three).
3. To conduct a systematic review synthesising the barriers and facilitators to yoga practice in people with arthritis (Chapter Four).

4. To conduct a qualitative study exploring the clinical knowledge, experiences, and perceptions of yoga providers in arthritis treatment in the UK (Chapter Five).

With the conceptual and contextual foundations established in this introductory chapter, the next chapter presents the first empirical component, i.e., a systematic review and meta-analysis synthesising the key characteristics of effective yoga interventions as a complementary approach for osteoarthritis treatment.

Chapter Two: Key characteristics of effective yoga interventions as a complementary approach to osteoarthritis treatment: a systematic review and meta-analysis

2.1 Introduction

Osteoarthritis is the most common type of arthritis among adults, affecting more than 600 million people globally.[7] As discussed in Chapter 1, it poses tremendous health (physical and psychological), social, and economic implications for the affected individual and society, severely affecting the individual's self-efficacy and quality of life.[43-46] There is no cure for osteoarthritis; however, it can be managed through various treatments.[52] The traditional approaches to managing the symptoms rely mainly on pharmacological options (e.g., NSAIDs) along with non-pharmacological approaches (e.g., moderate- to high-intensity physical exercises).[52,53] However, side effects of long-term usage of pharmacological treatment options (e.g., gastrointestinal toxicity), limited adherence to non-pharmacological treatment approaches (due to exercise-related injuries), and costs associated with both approaches (e.g., treatment-related costs, equipment costs for exercise) are some of the reasons that potentially limit their use among individuals with osteoarthritis.[17,185]

Yoga, a non-pharmacological treatment approach, has been recommended for osteoarthritis by an international osteoarthritis clinical guideline[53,] and some studies have also proposed yoga as a beneficial practice for people with arthritis.[136,142] As introduced in Chapter 1 as an ancient

discipline including components such as yogic poses (asana), breathing practices (pranayama), and meditation (dhyana) and relaxation practices, has gained increasing attention as a safe and potentially beneficial adjunct in chronic musculoskeletal conditions.[126,136]

Existing systematic reviews and meta-analyses have reported the beneficial effects of yoga interventions on osteoarthritis symptoms, such as reduced pain and improved function.[169-176] These reviews have included RCTs[169-176], and in one review, also other study designs[174]. A systematic review and meta-analysis of 20 RCTs and two case series on knee and hip osteoarthritis showed that yoga significantly reduced pain scores (mean difference (MD) -1.82; 95% CI, -2.96 to -0.67) and improved physical function scores (MD -6.07; 95% CI, -9.75 to -2.39) compared to no intervention or usual care.[174] No adverse events related to yoga were reported.[169-176] Content, structure, and delivery characteristics are key features of a yoga intervention.[186] Here, the content of yoga sessions means yogic poses (asana), breathing practices (pranayama), and meditation (dhyana) and relaxation practices. Structure refers to the duration and frequency of yoga sessions and the total intervention duration. Delivery characteristics of yoga sessions include the intervention context, yoga instructors' details, and strategies to enhance

intervention uptake and adherence. Synthesising these key features of effective interventions is crucial in developing a high-quality yoga programme aimed at improving osteoarthritis outcomes.

However, all the above-mentioned systematic reviews have only examined the effectiveness of yoga for osteoarthritis and described or reported but not synthesised the content, structure, and delivery characteristics of yoga interventions to manage osteoarthritis.[169-176] Therefore, this systematic review and meta-analysis aimed to fill this gap in the existing literature by narratively synthesising the content, structure, and delivery characteristics of effective yoga interventions for treating osteoarthritis symptoms. The intention was to facilitate the identification of the key features of effective yoga interventions, which could be combined for use in subsequent trials to test the effects of this yoga intervention on osteoarthritis patients.

Review question: Among adults with osteoarthritis, what are the content, structure, and delivery characteristics of yoga interventions as a complementary approach that are effective in improving pain and/or function, compared with usual care or other non-yoga interventions?

2.2 Methods

This systematic review followed the Joanna Briggs Institute (JBI) methodology for systematic reviews of effectiveness and the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.[187,188] This review was conducted according to *a priori* published protocol[189] and registered with the International Prospective Register of Systematic Reviews (PROSPERO) (registration number – CRD42022298155).

2.3 Inclusion criteria

Population: This systematic review included studies conducted among adults (aged ≥18 years) diagnosed with osteoarthritis of one or more joints. No restrictions were applied regarding the diagnostic criteria of osteoarthritis; diagnoses based on physical examination, radiographic, and MRI findings and/or arthroscopy were included.

Intervention: Studies reporting at least one of the major components of yoga, namely, asana (yogic poses), pranayama (breathing practices), and dhyana (meditation) and relaxation practices, were included. There were no restrictions on the type, frequency, duration, and delivery mode of the yoga intervention. Studies were excluded if they did not explicitly label the intervention as yoga.

Comparator: Studies comparing yoga interventions with no intervention, sham intervention, non-pharmaceutical intervention (e.g., diet, physical activity, and educational intervention), or pharmaceutical intervention (e.g., NSAIDs) were included. Studies with only a head-to-head comparison of two or more yoga interventions (i.e., different in terms of content, structure, or delivery characteristics) were excluded.

Outcome: Studies that assessed the core outcomes of osteoarthritis, i.e., pain and/or function, as recommended in several guidelines, were included.[52,67,190-192] Pain assessed using any scale (e.g., VAS and NRS) and function assessed using any scale (e.g., AIMS), including any joint-specific scale (e.g., KOOS, HOOS) was eligible.[52,190]

Study design: Only RCTs were included in the systematic review, considering the feasibility and practical aspects of the research, as well as the hierarchy of study designs. According to the hierarchy of evidence, RCTs represent the most rigorous design for assessing causal relationships between interventions and outcomes, minimising confounding and selection bias.[187,188] The decision to focus exclusively on RCTs is consistent with methodological guidance from the

JBI guideline, which recommends this approach when evaluating intervention effectiveness.

2.4 Data sources and search strategies

The following 13 databases were searched to find published studies from their inception dates to 22 September 2023: (i) MEDLINE (Ovid), (ii) EMBASE (Ovid), (iii) PsycInfo (Ovid), (iv) CINAHL (EBSCOHost), (v) Cochrane Central Register of Controlled Trials (CENTRAL), (vi) Allied and Complementary Medicine (AMED) (Ovid), (vii) SPORTDiscus (EBSCOhost), (viii) Web of Science (Clarivate Analytics), (ix) Turning Research Into Practice (TRIP), (x) AYUSH Research Portal (http://ayushportal.nic.in/, accessed 22 September 2023), (xi) A Bibliography of Indian Medicine (ABIM) (http://indianmedicine.eldoc.ub.rug.nl/, accessed 22 September 2023), (xii) CAM-QUEST (https://www.cam-quest.org/en, accessed 22 September 2023), and (xiii) Physiotherapy Evidence Database (PeDro). Unpublished studies were searched using (i) OpenGrey (from 1997), (ii) EthOS (from 1925), (iii) ProQuest Dissertations and Theses (from 1980), and (iv) DART-Europe-e-theses portal (from 1999). No language restrictions were applied. The search strategies were developed based on the following and in consultation with a Research Librarian at the University of Nottingham (UK): (i) the yoga component was based on a

previous relevant systematic review[193], (ii) the osteoarthritis component was based on the search strategies reported in the UK's NICE guidelines for osteoarthritis treatment[194] and existing Cochrane systematic reviews on osteoarthritis[195,196], and (iii) the pre-designed search filters for RCTs were used[197-199]. All the search strategies are detailed in Appendix 1. The reference lists of all the included studies and relevant previous systematic reviews were screened for additional studies.

2.5 Study screening and selection

Following the searches, all the identified citations were collated and uploaded to EndNote X9 (Clarivate Analytics, PA, USA), and duplicate citations were removed.[200] The remaining records were uploaded into Rayyan (Qatar Computing Research Institute [Data Analytics], Doha, Qatar), a web application, to facilitate the title and abstract screening process.[201] Titles and abstracts were screened for eligibility by two independent reviewers, using the inclusion criteria. Studies identified as potentially eligible or those without an abstract had their full texts retrieved. The full texts of the studies were assessed in detail against the inclusion criteria for eligibility by two independent reviewers. Full-text studies that did not meet the inclusion criteria were excluded and the reasons for exclusion were reported. Any disagreements that arose between the two reviewers were resolved through discussion. If a consensus was not reached, then a third reviewer was involved.

2.6 Assessment of methodological quality

The included studies were critically assessed using the standardised JBI critical appraisal tool for RCTs.[187] This tool has 13 criteria that can be scored as being met (Y), not met (N), unclear (U) or not applicable (n/a). One of the criteria was about blinding of intervention deliverers, which was not possible with yoga interventions and was scored as not applicable. Two reviewers independently assessed each criterion and commented on it. Any disagreements that arose between them were resolved through discussion. If a consensus was not reached, then a third reviewer was involved. Regardless of methodological quality, all studies underwent data extraction and synthesis.[187]

2.7 Data extraction

Data were extracted from the included studies using a pre-developed and pre-tested data extraction form by two independent reviewers. If a consensus was not reached through discussion, a third reviewer was consulted. The extracted data included the following characteristics of studies: author and year of publication, country, major inclusion criteria (including diagnosis), participant characteristics (age, sex, joint affected, duration of osteoarthritis, any other therapy or medication for

osteoarthritis), sample size, intervention and comparator details, study outcomes (pain, function, and adverse events), dropouts/withdrawals/discontinued interventions due to adverse events, and data extraction time point (in weeks). In addition, the characteristics of yoga interventions were extracted: intervention development, intervention duration, content (e.g., asana, pranayama, and dhyana and relaxation practices), structure (e.g., session duration and frequency), and delivery characteristics (location, settings, characteristics of yoga providers, and strategies used to monitor and increase adherence to interventions). For both the outcomes (pain and function), the authors extracted the end-of-intervention data, as previous studies have shown that intervention effects can diminish once treatment has ended; the time since the end of treatment was considered important.[196] Where this time point was not reported, data from the time point closest to the end of the intervention were extracted.

Intention-to-treat (ITT) data were preferred compared to per-protocol data.[202,203] Post-intervention data were extracted in preference to change from baseline data (i.e., post-intervention score - baseline score). Percentage change from baseline was not extracted, as it is highly sensitive to change in variance, and it also fails to protect from baseline

imbalances, leading to non-normally distributed outcome data.[204]

Pain and function are typically reported as continuous data, so the mean and standard deviation (SD) were extracted. Where no SDs were available, they were calculated from standard error (SE), CIs, or interquartile ranges (IQRs), using the formula from the Cochrane Handbook.[205] Where mean and SD for more than one intervention or control group were reported, the combined sample size, mean, and SD were calculated using the formulae in the Cochrane Handbook.[205] Yoga-related adverse events, where reported, were extracted. The corresponding authors of studies were contacted by e-mail (two times per author) to obtain missing or unclear data.

2.8 Data synthesis

Considering the common errors in how some study authors analyse and report yoga interventions to be effective in studies (e.g., conducting pre-post analysis of outcomes within study arms, but no comparative analysis between study arms), meta-analyses was conducted for yoga vs. any comparator to determine the true effectiveness of each included yoga intervention for both outcomes – pain and function. The meta-analyses were conducted using Review Manager 5.4.1 (Copenhagen, The Nordic Cochrane Centre, The Cochrane

Collaboration).[206] Random-effects meta-analyses were conducted due to the heterogeneous nature of the yoga interventions. Pain and function were measured using validated continuous scales, most commonly the Visual Analogue Scale (VAS; 0-10 cm or 0-100 mm) or Numerical Rating Scale (NRS; 0-10) for pain, and disease-specific instruments such as the WOMAC, KOOS, or HOOS for function, where higher scores indicate worse outcomes. Since the included studies used different scales to report pain and function measures, all results were standardised and expressed as standardised mean differences (SMDs) with 95% CIs, calculated using forest plots. Statistical heterogeneity was assessed using the I^2 statistic, with I^2>50% indicating substantial heterogeneity.[205]

Subsequently, a narrative synthesis of the yoga interventions identified as effective from the meta-analyses for pain and function were conducted, focusing on the content (e.g., yogic poses, breathing practices, meditation and relaxation practices), structure (e.g., duration and frequency of sessions), and delivery characteristics (group or individual sessions) of the yoga interventions. Commonalities and differences of the yoga interventions effective for one or both outcomes were also summarised. The Sanskrit and English names of all the yogic components used in the effective interventions and

the number of RCTs using these practices were tabulated. To examine whether study-level characteristics, such as the duration or frequency of yoga sessions, were associated with variations in treatment outcomes (i.e., pain reduction and functional improvement) in people with osteoarthritis, a random-effects meta-regression analysis was conducted using STATA 17 (StataCorp, 2021).[207,208] This approach extended the analysis beyond effect size estimation and p-values, enabling the evaluation of statistical associations between covariates (independent variables) and SMDs of pain and function outcomes (dependent variables).[209] Meta-regression is particularly useful in the presence of substantial heterogeneity, as it facilitates the identification of potential sources of variability across studies.[208-210] Based on Cochrane recommendations, the plan was to consider meta-regression if at least 10 studies could be included in the meta-analysis.[211] To ensure adequate statistical power, covariates were selected and categorised after data extraction. The anticipated categories included: (1) intervention content (e.g., yogic poses, breathing practices, meditation, relaxation); (2) structural features (e.g., session frequency and duration); and (3) delivery characteristics (e.g., individual- versus group-based formats).[209] The extent to which these covariates explained between-study heterogeneity was assessed using changes in the I^2 statistic, based on the DerSimonian-Laird

random-effects model.[208,210] Bubble plots were used to explore associations between these covariates and outcome effects visually.[208]

2.9 Results

2.9.1 Study selection

6693 records were identified through the literature search. After removing duplicate records and title and abstract screening, 44 articles were retrieved for full-text screening. 18 articles were included in this systematic review, representing 16 studies (RCTs) and 1402 participants.[212-229] Three articles described the same RCT, providing data on different outcomes and therefore, were included as a single study in this review.[213-215] The study selection process is detailed in the PRISMA flowchart as shown in Figure 6. No additional articles were identified from citation searching. The list of articles ineligible following the full-text review and ongoing RCTs identified from trial registries is presented in Appendix 2.

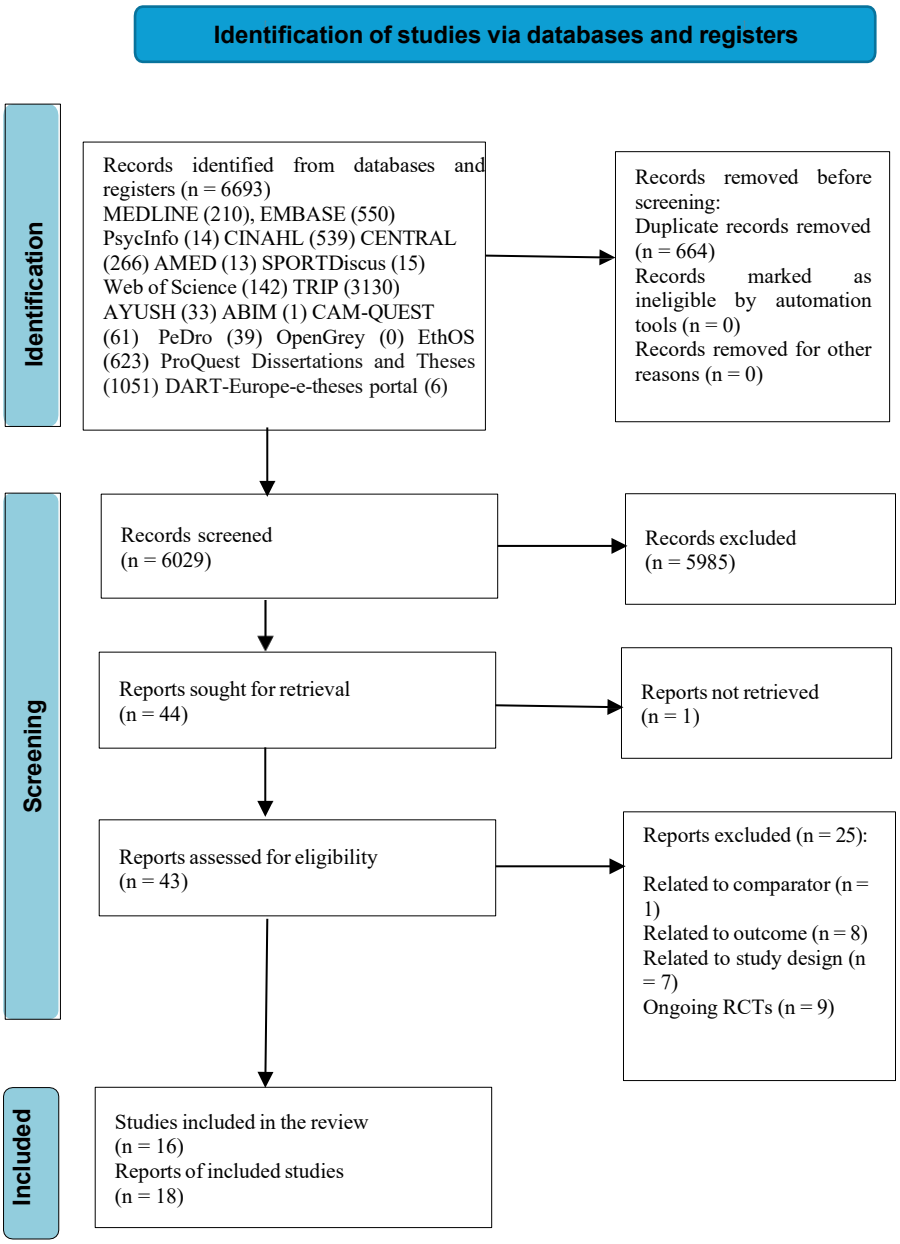


Figure 6 PRISMA flowchart for included studies from searches of databases and registers only.

2.9.2 Description of the included studies

Nine studies were conducted in the USA[212,216-220,224,225,228], four studies in India[213-215,221,222,226], one study in Canada[223], one study in Iran[227], and one study in Australia[229]. The sample size of the studies ranged from 18 to 250. Studies recruited participants aged between 18 and 90 years and where reported, the mean age varied from 57 to 79 years. 13 studies included male and female participants and the remaining three recruited only female participants.[216,222,223] Where exact numbers were reported, female and male participants were 1049 and 333, respectively. Five studies included participants with osteoarthritis of one or more lower extremity joints, including knee, hip, ankle or feet[217,219,220,224,225] and nine studies included specifically knee osteoarthritis[213-215,216,218,221-223,226,227,229], one on hand osteoarthritis[212], and the affected joint was unclear in another study[228]. Where reported, the duration of osteoarthritis amongst participants ranged from more than a month[227] to more than two years[213-215]. Of 16 studies, seven reported the use of pain medications among the participants.[216,219,223-225,228,229] In four of seven studies, it was unclear if the participants used pain medications before and/or during the trial.[216,219,224,225] Where reported, 25% to 63% of participants used pain medications.[219,224] Three of seven studies explicitly reported the use of pain medications among participants

before the trial[223,228,229], and where specified, this ranged from 61% to 73%[223,229]. In addition, three of 16 studies reported the use of non-pharmacological pain management (using physical therapy) before the trial, amongst 40%, 61%, and 78% of the participants, respectively.[219,228,229] Table 8 reports the characteristics of the studies. Table 9 presents the details of the yoga interventions (e.g., content, structure, and delivery characteristics) in the included RCTs.

Table 8 Characteristics of included studies.

Author and year	Country	Major inclusion criteria, including diagnosis	Population characteristics (Age in years (M±SD), sex(F/M), joint affected, duration of OA, any other therapy/medication for OA)					Sample size (n)	Intervention (I)	Comparator (C)
			Age in years (M±SD)/M (95%CI)	Sex (F/M)	Joint affected	Duration of OA	Any other therapy/ medication for OA			
Garfinkel, 1994	USA	Pain and/or stiffness in the hands. Diagnosis: ACR guidelines	I=NR C=NR	Both sexes, (14/11)	Hands	NR	NR	25 (I=14, C=11)	I=Yoga program (yoga and relaxation techniques) and health education on OA	C='Largely' drug-based treatment program
Ebnezar, 2011, 2012a, 2012b	India	Persistent, moderate to severe walking pain for 3 months before recruitment Kellegren and Lawrence radiologic grading of II–IV in X-rays taken within last 6 months.	I=59.56±8.18, 59.56± 9.54 (Ebnezar 2012b) C=59.42± 10.66	Both sexes, I:88/37 C:86/39	Knee	<1 year: I=62, C=59 1–2 years: I=39, C=40 >2 years I=24, C=26	NR	250 (I=125, C=125)	I=IYT practice [including lectures and counselling on yoga and health] +(physiotherapy +TENS+ultrasound)	C=40 mins of non-yogic physiotherapy exercises[a] supervised by certified therapists+ (physiotherapy+ TENS+ultrasound)

		-Diagnosis: ACR guidelines								
Cheung, 2014	USA	Community -dwelling adults aged 65-90 years. Symptomatic OA diagnosis for 6 or more months. -No previous yoga training. -Not currently participating in a supervised exercise programme. -Diagnosis: ACR guidelines	I=71.90 (69.30, 74.60) C=71.90 (69.00, 75.00)	Females, 36	Knee	≥6 months	Medication for arthritis (NS)	36 (I=18, C=18)	I=Hatha yoga	C=Wait-list control (60 mins session/week and 30 minutes/day four times a week at home)
Park, 2016	USA	Community -dwelling adults aged ≥65 years. -Self-	All=75.30± 7.50	Both sexes, (75/25)	One or more lower extremity joints	NR	NR	100 (I1=32, I2=20, C1=28, C2=20)	I1=Sit 'N' Fit chair yoga (English) I2=Sit 'N' Fit chair yoga (Spanish)	C1=HEP (English) C2=HEP (Spanish)

		reported joint pain caused by OA. Pain for 3 or more months. Diagnosis: by a board-certified nurse practitioner using the criteria-based on OA symptoms.								
Cheung, 2017	USA	Community-dwelling adults aged ≥60 years. -Self-reported medical diagnosis of symptomatic OA for 6 or more months. No previous training in any form of yoga.	I=68.90± 7.70 C1=74.40± 7.50 C2=71.80± 8.00	Both sexes, (70/13)	Knee	≥6 months	NR	83 (I=32, C1=28, C2=23)	I=Hatha yoga	C1=ASE[b] (centre-based supervised group sessions and home-based unsupervised individual sessions, for 8 weeks) C2=Education attention for 8 weeks (education brochures from the Arthritis Foundation on how to manage OA pain, and physical activity and exercise for OA)

		Not currently participating in a supervised exercise programme Diagnosis: NR								
McCaffrey, 2017	USA	Community-dwelling adults aged ≥65 years. -Self-reported joint pain caused by OA. -Moderate chronic pain for 15 or more days per month for 3 or more months. -Diagnosis: by a nurse practitioner based on OA symptoms.	I=75.90± 8.20 C=74.50± 6.50	Both sexes, (85/27) I=66/19, C=19/8	One or more lower extremity joints	NR	Pain medication n=70 (unclear if before or during the trial) History of non-pharmacological pain management n=45	112 (I=85, C=27)	I=Sit 'N' Fit Yoga program (chair yoga)	C=HEP (health education sessions, including social interaction through games, lecture and discussion, by a health educator regarding OA)

Park, 2017	USA	Ages≥65 years. Self-reported joint pain. Moderate chronic pain (≥4 on a pain bother scale at least 15 days per month for ≥3 months. Diagnosis: by a geriatric nurse practitioner	I=75.90± 8.20 C=74.50± 6.50	Both sexes, (I:44/19, C:41/8)	One or more lower extremity joints	NR	NR	112 (I=63, C=49)	I=Sit 'N' Fit chair yoga	C=HEP (45-min health education sessions by a healthcare provider on OA)
Deepeshwar, 2018	India	OA>3 months. Diagnosis: by a physician.	I=59.80± 10.21 C=61.07± 9.17	Both sexes, (I:25/6, C:25/10)	Knee	>3 months	NR	66 (I=31, C=35)	I=IAYT	C=Conventional treatment without any form of yoga intervention
Kaur, 2018	India	Diagnosed with mild or moderate OA. Not advised for surgery (viz. early OA). Diagnosis :	I=52.42± 4.60 C=54.23± 4.80	Females, 83	Knee	NR	NR	83 (I=43, C=40)	I=Distribution of SIM + intervention package (group training through lectures and demonstrations (yoga asana & guided meditation)) one-to-one training	C=Distribution of SIM

		ACR criteria for classification of idiopathic knee OA.							through demonstration	
Kuntz, 2018	Cana-da	Ages≥50 years. Diagnosis: ACR guidelines.	I=65.50± 5.60 C1=63.70± 8.90 C2=71.10± 9.30	Females, 31	Knee	NR	Pain medication n n=19 (during the trial)	31 (I=10, C1=11, C2=10)	I=Yoga exercise	C1=Traditional exercise (knee strengthening and aerobic warm-up, balance exercises, and stretching. C2=No exercise (group-based, guided meditative relaxation classes led by a certified yoga-instructor)
Zacharia, 2018	USA	Community -dwelling adults aged 40-64 years. Insufficient ly active (<30 min a day of moderate activity, five days a week, or <150 min of moderate activity a	All=57± 4.10 not reported separately for I/C	Both sexes, not reported separatel y for I/C	Lower limb joints (hip, knee, ankle, or feet)	>6 months	Pain medications n=5 (unclear if before or during the trial)	20 (I=10, C=10)	I=Hatha Yoga Program (Phase-1)+relapse Prevention programme (Phase-2)	C=No intervention

		week) or sedentary. Diagnosis: NR								
McCaffrey, 2019	USA	Ages ≥62 years. Reported OA-associated pain. Chronic pain at least 15 days of the month for ≥3 months Diagnosis: by a nurse practitioner	All=78.80± 8.90, I=79.00± 2.50 C=78.00± 2.10	Both sexes, (I:5/4, C:5/4)	Lower extremity joints (hip, knee, other LEs)	NR	I=Tylenol (acetaminophen), tramadol, ibuprofen n=3 C= Tylenol (acetaminophen), ibuprofen n=5 (unclear if before or during the trial)	18 (I=9, C=9)	I=Chair yoga (based on traditional Hatha yoga postures)	C=Chair exercise[c]
Vaghela, 2020	India	Ages 40-80 years. -Diagnosis: clinical ACR criteria	I=56.58± 10.12 C=54.27± 8.44	Both sexes, (I:28/15, C:30/10)	Knee	NR	NR	83 (I=43, C=40)	I=Conventional physiotherapy+yoga therapy	C=Conventional physiotherapy: 1.Transelectrical nerve Stimulation (10 min) 2.Isometrics quadriceps exercise 3. Straight leg-raising exercise in supine 4. Terminal knee extension or vastus medialis oblique strengthening exercise

										in supine and high sitting 5.Straight leg abduction exercise in side lying.
Bokaeian, 2021	Iran	Ages 45–76 years. Knee pain of 30 or greater on the 100-mm VAS. Diagnosis: Unilateral or bilateral tibiofemoral joint OA of grades 2–3 based on the Kellgren–Lawrence grading system.	I=54.90± 5.00 C1=57.00± 4.90 C2=56.70± 4.70	Both sexes, (45/14) (I:16/6, C1:15/4, C2:14/4)	Knee	Knee pain> 1 month	NR	59 (I=22, C1=19, C2=18)	I=Yoga exercises and medial-thrust gait (YogaMT) training	C1=Knee muscle strengthening C2=Treadmill walking
Park, 2021	USA	Ages≥60 years. Moderate chronic OA pain of any joint for ≥15 days per month for ≥3 months. Diagnosis:	All=75.30± 7.50, not reported separately for I/C	Both sexes, (85/27)	NR	NR	Current pain medication n n=71 History of non-pharmacological pain management n=68	112 (I=47, C=65)	I=Chair yoga	C=Health education programme consisting of information on OA by a healthcare provider

		NR								
Bennell, 2022	Australia	Ages ≥45 years. Activity-related knee pain for at least 3 months. Average walking pain score of ≥4 on an 11-point numerical rating scale over the previous week. No knee morning stiffness lasting ≥30 min) Diagnosis: NICE clinical criteria*	I=62.80± 8.20 C=61.80± 7.20	Both sexes, (I:70/37, C:78/27)	Knee	Knee pain >3 months	Current pain medications: I&C= NSAIDs, acetaminophen, topical NSAIDs, oral corticosteroids and oral opioids. History of treatment in last 3 months: - Massage/ manual therapy -Gait aid -Thermal therapy/electrotherapy - Orthotics, arch supports, or wedging	212 (I=107, C=105)	I=Online yoga programme plus online education.	C=24-weeks unlimited access to a customized trial website containing downloadable educational covering understanding OA, treatment options, exercise and physical activity, weight loss, understanding and managing pain, sleep, and patient stories

							in shoes -Knee braces -Land-based and water exercises -Joint injections -Acupuncture -Knee surgery			

Note: Only yoga-related interventions were mentioned under intervention, and no intervention or any other active interventions were mentioned under comparator. OA: osteoarthritis, ACR: American College of Rheumatology, NR: Not reported, ADL: Activities of daily living, IYT: Integrated Yoga Therapy, TENS: Transcutaneous Electrical Stimulation, HEP: Health Education Programme, IAYT: Integrative Approach for Yoga Therapy, SIM: Self-Instruction Manual, NSAIDs: Non-Steroidal Anti-Inflammatory Drug, [a]Physiotherapy exercises included loosening and strengthening practices for upper and lower limb joints, rest, specific knee practices, and supine rest followed by light music. [b]Weekly group sessions by an instructor for 8 weeks (15 min mild aerobic exercise and 30 min of strengthening exercises including both isometric (without moving the joints) and isotonic (moving the joints) exercises. Home practice: aerobic exercise for 15–30 min/day, four times/week, and the strengthening exercises for 30 min/day, two times/week on non-consecutive days. [c]Chair exercise consisting of progressive resistive exercises incorporating body weight and/or external resistance using cuff weights, resistance bands, and balls, NICE clinical criteria: (age ≥45 years, activity-related knee pain, and no knee morning stiffness lasting≥30 min)

Table 9 Intervention details (key features of content, structure and delivery characteristics) of the included RCTs.

Author and year	Intervention development and duration	Yoga sessions: content			Yoga sessions: structure (duration and frequency)	Yoga sessions: delivery characteristics (location, settings, instructor, monitoring and adherence)	Extra features
		Asana	Pranayama	Dhyana and relaxation			
Garfinkel, 1994	Based on a literature review on OA, and the study and practice of hatha yoga consisting of supervised yoga and relaxation techniques and patient education; 10 weeks	-Parvatasana (mountain pose)	-Attention to respiration	-NR	I=60 min session/ weekX10 weeks (1^{st} and 10^{th} session devoted to pre and post testing)	-Centre-based group sessions delivered and supervised by a health educator and yoga teacher.	-Written instructions of educational materials provided weekly. -Group discussion, supportive encouragement and general QnA. -No information on encouragement for yoga practice after the intervention.

Ebnezar, 2011,2012a, 2012b	**-Developed from the traditional yoga scriptures (Patanjali yoga sutras, yoga vasishta, and Upanishads); 12 weeks**	**-Yogasanas-10 min Standing asanas: Tadasana (mountain pose), Ardha Kati Chakrasana (lateral arc pose), Ardha Chakrasana (half wheel pose), Prasarita Padahastasana (wide-legged standing forward bend pose) Lying asanas: Bhujangasana (Cobra pose), Shalabasana (locust pose), Viparita Karani (legs-up-the-wall pose), Dhanurasana (bow pose) (reported only in Ebnezar 2012a)**	**Nadishuddhi pranayama (alternate nostril breathing)-3 min**	**OM meditation-2 min, Deep relaxation technique-5 min, Quick relaxation technique--3 min, Instant relaxation technique-2 min**	**I=40 min IYT (25 mins of asana, pranayama and dhyana and relaxation practices)+20 min (physiotherapy with TENS and ultrasound)/6 days/week X 2 weeks+40 min IYT/day at home daily X 12 weeks**	**-Centre-based group sessions at a hospital basement and home-based individual sessions. -Sessions delivered and supervised by certified therapists. -Home practice documented in diaries, telephone calls once in 3 days and a weekly review to monitor home practice.**	**-Other practices in the IYT session included loosening practices of foot and ankle, knee, hip and waist, upper limbs, and neck, strengthening exercises. -Lectures and counselling on yogic concepts of health and disease, yama, niyama, bhakti yoga, Jnana yoga and karma yoga were included in the yoga module. --Sessions for 40 min daily (6 days/week) after physiotherapy (20 min) for 2 weeks.**
Cheung, 2014	**-Designed by a panel of five certified yoga teachers who had**	**-Asanas in the seated, supine, and standing**	**-NR**	**-Relaxation poses**	**I=60 in/weekX8 weeks+30 min/dayX4**	**-Centre-based group and home-based**	**-Poses with static stretching,**

	experiences teaching older adults. **- Reviewed by 2 yoga researchers and a yoga master; 8 weeks**	**positions with the following key postures:** **Tadasana (mountain pose), Virabhadrasana I (warrior I pose) and Virabhadrasana II (warrior II pose), Vrksasana (tree pose), Utkatasana (chair pose), Sukhasana (easy seated pose), Baddha Konasana (bound angle pose), Upavistha Konasana (open angle pose), Ardha Shalabhasana (half locust pose), Setu Bandha Sarvangasana (bridge pose), Uttanasana (standing forward fold reclining pose), Hamstring stretches,**			**times a week of yoga practice at home for 8 weeks**	**individual sessions at a yoga studio.** **-Sessions delivered and supervised by a registered yoga teacher.** **-Handouts of illustrated yoga poses were distributed for home practice.** **-Log sheet used for monitoring home practice.**	**balance, and strength exercises.** **-Mats, blocks, straps, blankets, and chair used during class, and poses were modified as per individual needs.**

		Reclining twist					
Park, 2016	**-Developed by a research team of health care providers with a yoga teacher who has taught yoga for more than 15 years, certified by the International Yoga Alliance; 8 weeks**	**Body proper-20 min, Virabhadrasana (warrior in the body pose)-5 min**	**Breath of life-10 min**	**Mind-body connection-10 min**	**I=45 minX2/weekX8 weeks**	**-Centre-based group sessions delivered and supervised by a certified yoga instructor at community sites. -Participants were given a Sit 'N' Fit chair yoga manual with detailed instructions and pictures for home practice after 8 weeks.**	**-Chair used as a support for standing poses -Each yoga cohort at each site had a maximum ratio of participants to instructor of 10:1 -CY manual translated to Spanish, for Spanish-speaking participants**
Cheung, 2017	**-Designed by a group of expert yoga teachers; 8 weeks**	**-Poses in seated, supine, prone and standing positions. Supta Baddha Konasana (reclining bound angle pose), Ardha Salabhasana (half locust variation), Janu Sirsanana (head to knee pose), Uttanasana**	**NR**	**Relaxation pose**	**I=45 min/weekX8 weeks+30 min/dayX4 times a week of yoga practice at home for 8 weeks.**	**-Centre-based group and home-based individual sessions. -Centre-based sessions delivered and supervised by certified instructor. -Handouts with pictures and written instructions**	**-Use of props: yoga mats, blocks, straps, blankets, and chairs -Poses were modified when needed**

		(standing forward fold pose), Utkatasana (chair pose), Tadasana (mountain pose), Virabhadrasana I (warrior I pose), Virabhadrasana II (warrior II pose), Vrksasana (tree pose) variation, Reclining hamstrings stretch with hip opener with strap, Reclining twist				**were distributed for home practice. -Home practice monitored using video recordings, and self-recorded yoga/exercise log sheets.**	
McCaffrey, 2017	-Created by a master yoga instructor and used in 2 pilot studies to determine feasibility and participant satisfaction. -Sit "N" Fit is based on the foundation of Iyengar Hatha Yoga; 8 weeks	-Body Proper-20 min -Warrior in the Body-5 min: Saaras Pakshi asana (stork pose), Bhujangasana (cobra pose), Vrksasana (tree pose),Salabhasana (locust pose), Ardha Chandrasana (half-moon pose),	-Breath of Life-10 min (1 breathing technique per class) Diaphragmatic breathing, Nadi Shodhana Pranayama (alternate nostril breathing), Ocean breath	-Mind-Body Connection-10 min Tense and relax, Total body guided relaxation, Guided visualisation	I=45 minX2/week X8 weeks	-Centre-based group sessions delivered and supervised by certified yoga instructors. -Manuals with instructions and pictures was provided for home practice. -Post intervention,	-Chair used as a support for standing poses.

		Bharmanasana (table pose)	(Ujjayi breath)			participants were asked to continue to do the yoga program at home at least twice a week and to document home practice.	
Park, 2017	**-Developed by a master yoga instructor with more than 20 years of experience with older adults. It was built on the Iyengar Hatha yoga technique, recommended by the NCCIH; 8 weeks**	**-NR**	**-NR**	**-NR**	**I=45 minX2/week X8 weeks**	**-Centre-based group sessions at a senior housing facility and a senior day centre delivered and supervised by certified yoga instructors. -Post intervention, participants were given a manual with instructions and pictures for home practice. -Participants were asked to report frequency, duration,**	**-Chair was used. -Fidelity of yoga was ensured by the program developer.**

						and components of home practice after 3 months.	
Deepeshwar, 2018	-Developed using a holistic approach to health management at physical, mental, emotional, and intellectual levels; 1 week	-Asanas (yoga postures) – 19 mins Sitting – 6 mins Paschimottasana (seated forward bend pose)-3 rounds min), Bhunamanasana (earth salutation pose)-3 rounds (3 mins) Prone – 6 mins Bhujangasana (cobra pose)-3 rounds (3 min), Salabhasana (locust pose) – 3 rounds (1 min), Vipareetkarani (inverted pose)- 2 min Supine – 7 mins Setubandhasana (bridge pose)-2 rounds (1 min), Markatasana	Total - 32 mins -Pranayama (yoga breathing) – 12 mins Vibhagıya Pranayama (sectional breathing)-3 rounds (3 min), Nadı-shuddhı pranayama (alternate breathing)-9 rounds (3 min), Brahamarı Pranayama (humming bee breathing)-9 rounds (3 min), Bhastrika Pranayama (bellows breathing)-9 rounds (3	- Total – 82 mins Savasana (Corpse pose)-5 min -Relaxation Techniques – 17 mins Instant relaxation technique-2 min, Quick relaxatio n technique- 5 min, Deep relaxation technique- 10 min -Cyclic meditation- 30 min -Om meditation and	I=133 minX2 times a dayX1 week.	-Centre-based group sessions delivered (supervised? unsupervised?) at a yoga centre of S-VYASA in Bangalore, India.	-Lectures and individual yogic counselling -Loosening practices in standing – 6 mins Twisting- 5 rounds (2 mins), Side bending- 5 rounds (2 mins) on each side Loosening practices in Sitting – 12 mins Knee cap tightening-, 5 rounds (2 mins each), both legs, Passive Patella Movement (Up and Down, In and Out, Rotation)- 10 rounds (4 min) both legs, Knee bending- 5 rounds (2 min) each, both legs Loosening

		(lumbar stretch pose)-2 rounds (1 min)	**min)** **-Cooling pranayama – 9 mins** **1.Sıtali (rolling tongue breathing)-9 rounds (3 min)** **2.Sitkarı (folded tongue breathing)-9 rounds (3 min)** **3.Sadanta (clenched teeth breathing)-9 rounds (3 min)** **-Kapalabhati (frontal brain cleansing breath)-5 min** **-Breathing practices – 6 mins** **Hands in and out breathing-5 rounds (2**	**devotional sessions (prayers)-10 min** **-Mind sound resonance technique-10 min** **Nadanu-sandhana (A,U,M and A-U-M Kara chanting)-10 min**			**practices in supine – 6 mins** **Folded Leg Lumber Stretch (Left, Right, Both)- 5 rounds (2 min), Cycling-5 rounds (2 min) both legs, Straight Leg Raising (Left, Right and Both)- 5 rounds (2 min)** **-Kriyas (cleansing techniques) everyday twice (morning and evening) – 55 mins** **Jalaneti (nasal cleansing with water)-30 min, Vamanadhouti (internal cleansing by water)-15 min, Trataka (candle light gazing)-10 min**

			min), Hands stretch breathing-5 rounds (2 min), Ankle stretch breathing-5 rounds (2 min)				
Kaur, 2018	**-Developed in Punjabi (vernacular) language and circulated among yoga specialists for consensus validity. It was modified as per the feedback received; 6 months**	**-NR**	**-NR**	**-NR**	**I=60 minsX2/monthX2 months+60 mins/monthX4 months**	**-Centre-based group sessions (supervised) through lectures and demonstrations and home-based individual practice using self-instruction manuals. -Participants were asked to continue home practice during the intervention period.**	**-Joint conditioning exercises. -Participants required to attend six of the eight intervention sessions to be included in the analysis.**
Kuntz 2018	NR;12 weeks	-Selected weight-bearing, static poses which included squats and lunges with varying foot, trunk, and arm positioning.	None	-Supine body awareness exercise at the start of the session. -Supine deliberate relaxation	I=60 minX3/week X12weeks	-Centre-based group sessions delivered and supervised by a certified, trained yoga instructor. -Session attendance and	-Careful attention paid to the ideal alignment of the leg throughout the exercises. -Exercise difficulty was progressively

				exercise at the end of the session.		program adherence were monitored.	increased.
Zacharia, 2018	NR; 8 weeks	-14 Hatha yoga poses	-NR	-Relaxation using restorative poses-10 min Viparita Karani (leg-up-the-wall pose), Savasana (corpse pose)	1st phase: I=60 minX2/week X8 weeks 2nd phase: I=120 min/weekX4 weeks	-Centre-based group sessions through community classes, delivered and supervised by a certified yoga instructor. -Home-based individual practice using a yoga practice sheet with detailed instructions on an information brochure. -Participants were encouraged to continue yoga practice at home through weekly emails and phone calls and text messages. -Yoga practice log was used to monitor home	-For targeting social support, participants were encouraged to invite a family member or a friend to practice yoga with them. -The text messages included weekly tips on setting an effective yoga routine, and meet a weekly yoga target of 120 minutes/week. -The messages also included the names of yoga apps for smart phones, YouTube videos on practicing yoga at home, yoga classes currently conducted in the area, and long-term OA self-care tips.

						practice.	
McCaffrey, 2019	-Developed based on traditional Hatha yoga postures; 8 weeks	NR-25 min	NR-10 min	NR-10 min	I=50 minX2/weekX8 weeks	-Centre-based group sessions delivered and supervised by a certified yoga instructor certified by the National Yoga Alliance, conducted at a senior housing facility.	-Chair was used as a support.
Vaghela, 2020	**NR; 4 weeks**	**Six asanas: Tadasana (mountain pose), Utthita Trikonasana (triangle pose), Virabhadrasana (warrior pose), Dandasana (staff pose), Supta Padangustasana (reclining hand-to-big-toe pose), Baddha Konasana (bound angle pose)**	**None**	**None**	**I=30 minX3/weekX4 weeks**	**-NR**	**-Each asana consisted of ten repetitions with short intervals of rest.**
Bokaeian, 2021	NR; 4 weeks	-Goddess squat and warrior lunge exercises-20 min	None	None	I=20 minsX3/weekX4 weeks	-Group sessions delivered and supervised by a	-Level of difficulty of the goddess and

		Goddess squat: Level 1: hands on hips knees flex to 30°, Level 2: hands on hips knees flex to 60°, Level 3: shoulders flex to 90° elbows straight knees flex to 60°, Level 4: arms overhead knees flex to 80° Warrior lunge: Level 1: hands on hips, Level 2: shoulders flex to 90° with elbows straight, Level 3: arms overhead, Level 4: arms overhead look up to the ceiling for an added challenge				physiotherapist.	warrior exercises was adjusted based on the Borg Perceived Exertion Scale. -Participants also received thermotherapy with a hot pack for 20 min.
Park, 2021	-Developed by the research team that provided step-by-step instructions for continuing yoga at home; 8 weeks	NR-25 min	NR-10 min	NR-10 min	I=45 minX2/weekX8 weeks	-Centre-based group sessions at a senior housing facility or senior centre delivered and supervised by a yoga instructor and home-based individual sessions	-Chair was used. -Fidelity ensured by observing and assessing 20% of the sessions based on a standardised checklist developed by the research team.

						provided using guided manuals.	
Bennell, 2022	**-Designed by the researchers and a panel comprising 5 yoga therapists (registered with the International Association of Yoga Therapists or the Australasian Association of Yoga Therapists), 2 people with knee OA, and a physiotherapist with fitness leader qualifications and expertise in teaching yoga; 12 weeks**	**-Yoga postures to warm up the core and lower-extremity muscles-5 min -Static and dynamic yoga postures intended to activate, strengthen, and stretch core and lower-extremity muscles-20 min Knee to chest-Apanasana, Leg extensions supported squat- Utkata Konasana, Supported forward bend-Paschimottasana, Straddle seat Upavistha Konasana, Straddle seat prep standing forward lunge, Leg lifts, Hip lifts, Marching one leg balance, Wide leg**	**-NR**	**Cooldown of stretches+ relaxation exercises-5 min, Salamba Savasana (Supported rest)**	**I=30 minX3/weekX 12 weeks**	**-Home-based individual unsupervised sessions delivered online. -Pre-recorded videos included a demonstration of yoga by a yoga instructor (a physiotherapist and yoga teacher). -Weekly reminders and motivational emails sent to increase adherence.**	**-Video class instructor demonstrated various modifications and levels for each posture to ensure safety and feasibility -12 different pre-recorded 30-minute videos (1 video per week) -Upon completing the program, yoga practice was recommended but optional.**

		side bend, Standing side lunge- Skandasana, Knee hugs, Twisted pose, Wide leg forward bend (Prasarita Padottanasana)					

NR: Not reported (Only the terms- Asana, Pranayama or Dhyana and Relaxation practices were mentioned but not no details provided)
Note: Text in **bold:** Effective interventions for pain and/or function. None: No Mention of any of the terms – asana, pranayama or dhyana and relaxation practices, OA:osteoarthritis, QnA: question and answer, IYT: Integrated Yoga Therapy, TENS: Transcutaneous Electrical Stimulation, NCCIH: National Centre for Complementary and Integrative Health

2.9.3 Methodological quality of included studies

Table 10 reports the methodological quality of the included studies. Overall, the methodology was not adequately reported in the included studies, resulting in low methodological quality scores (total "yes" percentage ranging from 17% to 58%). In real practice, yoga providers delivering the yoga intervention cannot be blinded. So, the response to question 5 of the checklist was marked as N/A (not applicable) in our methodological assessment. Some of the major issues in these studies included: (i) inadequate reporting of the randomisation process used to assign participants to study arms and thus, it was unclear if true randomisation was used or not; (ii) inadequate reporting of the allocation concealment process and thus, it was unclear if the allocation to study arms was concealed or not; (iii) imbalance between the treatment groups at baseline; (iv) inadequate reporting of blinding of participants and outcome assessors (could have been achieved through sham therapies); (v) inadequate reporting of whether the study arms were treated identically, other than the intervention of interest; (vi) insufficient analysis of the differences between study groups about loss to follow up and reasons for loss to follow up in case of incomplete follow-up for the entire trial duration; (vii) inadequate reporting of ITT analysis and its details (i.e., whether participants were analysed in the groups to which

they were initially randomised); (viii) inadequate reporting of the measurement process of outcomes (including adverse events), and thus, it was unclear if the outcomes were measured in the same way for study arms or not; (ix) no or inadequate description of the number of raters who assessed outcomes or their training, hence making it unclear if outcomes were assessed in a reliable manner; and (x) issues in the statistical power analysis, unclear minimum clinically important difference for the sample size calculation, no information on the assumptions of statistical tests used, and errors in statistical analysis and reporting (e.g., pre-post analysis and not between groups).

Table 10 Methodological assessment of included studies.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Total % of "Y"
Garfinkel, 1994	U	U	U	U	N/A	U	Y	U	U	U	U	U	Y	17
Ebnezar, 2011	Y	U	Y	N	N/A	Y	Y	U	U	Y	U	U	Y	50
Ebnezar 2012a	Y	U	Y	N	N/A	Y	Y	U	U	Y	U	U	Y	50
Ebnezar 2012b	Y	U	Y	N	N/A	Y	Y	U	U	Y	U	U	Y	50
Cheung, 2014	Y	U	N	N	N/A	Y	U	Y	Y	U	U	N	Y	42
Park, 2016	Y	U	N	N	N/A	Y	U	U	N	Y	U	U	Y	33
Cheung, 2017	Y	U	Y	U	N/A	Y	U	U	Y	U	U	Y	Y	50
McCaffrey,2017	Y	U	U	U	N/A	Y	U	Y	Y	Y	U	Y	Y	58
Park, 2017	Y	U	U	U	N/A	Y	U	Y	Y	Y	U	U	Y	50
Deepeshwar,2018	U	U	Y	N	N/A	Y	Y	Y	U	Y	U	Y	Y	58
Kaur, 2018	U	U	Y	U	N/A	U	U	Y	N	U	U	U	Y	25
Kuntz, 2018	Y	U	N	U	N/A	Y	U	U	N	Y	U	U	Y	33
Zacharia, 2018	U	U	U	U	N/A	U	U	Y	U	U	U	Y	U	17
McCaffrey, 2019	Y	U	Y	U	N/A	Y	U	U	Y	U	U	N	Y	42
Vaghela, 2020	U	U	Y	U	N/A	U	U	N	N	Y	U	U	Y	25

Bokaeian,2021	N	U	N	U	N/A	Y	Y	Y	Y	Y	U	U	Y	50
Park, 2021	Y	U	U	U	N/A	Y	U	Y	Y	Y	U	U	Y	50
Bennell, 2022	Y	Y	N	N	N/A	Y	U	Y	Y	U	U	Y	Y	58

Y=yes; N=no; U=unclear; NA=not applicable.

JBI critical appraisal checklist for randomised controlled trials: Q1. Was true randomisation used for assignment of participants to treatment groups? Q2. Was allocation to treatment groups concealed? Q3. Were treatment groups similar at baseline? Q4. Were participants blind to treatment assignment? Q5. Were those delivering treatment blind to treatment assignment? Q6. Were outcomes assessors blind to treatment assignment? Q7. Were treatment groups treated identically other than the intervention of interest? Q8. Was follow-up complete and if not, were differences between groups in terms of their follow up adequately described and analysed? Q9. Were participants analysed in the groups to which they were randomised? Q10. Were outcomes measured in the same way for treatment groups? Q11. Were outcomes measured in a reliable way? Q12. Was appropriate statistical analysis used? Q13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomisation, parallel groups) accounted for in the conduct and analysis of the trial?

2.9.4 Adverse events

Adverse events were not reported in seven RCTs[212,213-215,221,222,224,226,227], while another seven RCTs explicitly reported that no adverse events occurred[216,217,219,220,223,225,228]. Two RCTs reported adverse events.[218,229] For instance, one RCT reported that no adverse events were found in the yoga intervention group but provided details on adverse events related to aerobic strengthening exercises used as a comparator.[218] In the other RCT, no serious adverse events were reported; however, a few non-serious adverse events were reported in both the yoga and comparator groups. These included pain in the knee, hip, back, foot, and upper limb, particularly among older adults with comorbidities.[229]

2.9.5 Meta-analysis to determine effective interventions

The extracted outcome data from all studies used for meta-analysis are provided in Table 11. Of 16 RCTs included in this review, two could not be included in the meta-analysis because of insufficient data to calculate the means and SDs for the yoga and control groups.[219,228] Therefore, a total of 14 studies (16 articles) were included in the meta-analysis to identify the individual effective interventions for each symptom - pain (13 studies) and function (13 studies). These studies compared yoga interventions with pharmacological and non-pharmacological

interventions.[212,213-215,216-218,220-227,229] Overall, yoga interventions reduced pain compared to pharmacological and non-pharmacological interventions (SMD -0.70; 95% CI -1.08 to -0.32) (Figure 7) and were effective in improving function compared to pharmacological and non-pharmacological interventions (SMD -0.40; - 0.75 to -0.04) (Figure 8).

Table 11 Extracted outcome data.

Author and year	Pain (Post-intervention) Mean±SD	Function (Post-intervention) Mean±SD	Adverse events (including serious adverse events)	Measurement time point at the end/closest to the end of intervention for pain and/or function	Dropouts/withdrawals/discontinued interventions due to adverse events
Garfinkel, 1994	Combined hands at rest (VAS): I=-1.86±5.63C=-0.09±2.91 **Hand pain during activity:** **I=-4.29±2.09C=-1.00±3.00**	Combined hands (Stanford Hand Assessment Questionnaire): I=-0.13±0.21C=0.21±0.79	NR	8 weeks	C=1 (dropped out before post testing)
Ebnezar, 2011,2012a,2012b	SF-6: I=73.77±12.67 C=46.93±11.22 Resting pain (NRS): I=1.94±1.11 C=4.17±1.51 **Walking pain (NRS):** **I=3.35±0.99 C=5.35±1.49**	SF36: I=67.50±9.09 C=50.94±14.76 **WOMAC:** **I=9.72±4.87** **C=27.66±13.78**	NR	12 weeks	I=72-Got relief on the 10th day and discontinued the treatment 3-Discontinued due to emergencies at home 2-Office calls C=83-Respiratory tract infections 2-Had relief and discontinued 1- Due to emergencies at home 2- Severe pain and could not continue the treatment, hence advised bed rest
Cheung, 2014	WOMAC: I=5.8±2.84 C=8.3±2.84	WOMAC: I=22.0±9.76 C=26.2±9.76	None	8 weeks	I=0 C=2 1-Busy schedule 1-Severe knee pain affecting mobility

Park, 2016	Pain Interference: Combined mean and SD for I1 and I2: I=5.15±2.43 Combined mean and SD for C1 and C2: C=8.48±0.59	NR	None	8 weeks	I=3 C=16
Cheung, 2017	WOMAC: I=5.1±2.63 Combined mean and SD for C1 and C2: C=6.5±2.46 **VAS:** **I=4.0±2.63** **Combined mean and SD for C1 and C2:** **C=5.21±1.87**	**WOMAC:** **I=18.2±8.04** **Combined mean and SD for C1 and C2:** **C=25.53±7.91** SPPB Global: I=10.6±1.39 Combined mean and SD for C1 and C2: C=10.34±1.33	I=None C1=Possible exercise-related injuries (1-fell on ice and experienced back pain 1-recurring low back pain with a history of herniated disk 1-developed leg pain halfway through the program which may have been related to a pre-existing condition of left patella femoral pain syndrome)C2= none	8 weeks	I=4 1-Health issue1-Too busy1-Work scheduleChanged1-Too busyC1=5 1-Lost to contact1-Fell1-Leg pain1-Back pain1-Too busyC2=1 1-Lost to contact

McCaffrey, 2017	WOMAC:Mean and SD cannot be calculated	WOMAC:Mean and SD cannot be calculated	None	8 weeks	n=13 (prior to the start of the intervention - 6 from the first cohort, 3 from the second cohort, and 4 from the third cohort) due to death in the family, schedule conflict, or unwillingness to be in the control group. -Of 112 who started the intervention, I= 6 6-lost to follow upI=55-withdrawal during the intervention
Park, 2017	**WOMAC:** **I=4.5±3.3** **C=6.4±4.6** PROMIS: I=15.1±7.3 C=18.3±8.9	WOMAC: I=14.8±11.4 C=20.4±14.8	None	8 weeks	I=2 1-injury1-surgeryC=11 6-not wanting to be in control group 4-due to illness 1-conflict with schedule
Deepeshwar, 2018	NR	TUG: I=15.57±5.23 C=19.02±5.19	NR	1 week	None
Kaur, 2018	VAS: I=6.34±1.1 C=6.97±0.6	KOS-ADL(Effect of symptoms on level of activity): I=21.50±3.5 C=19.69±3.4 **KOS-ADL (Level of limitation in activities of daily living):** **I=26.89±3.6** **C=24.76±4.1** TUG: I=9.87±1.0 C=9.97±0.9	NR	24 weeks	I=5 (Reason not reported) C=1 (Patient went abroad)

Kuntz, 2018	**KOOS (/100):** **I=70.3±12.8** **Combined mean and SD for C1 and C2:** **C=58.12±20.80** Intermittent Pain (/100): I=28.5±16.9 Combined mean and SD for C1 and C2: C=39.86±24.79 Constant Pain (/100): I=12.0±14.9 Combined mean and SD for C1 and C2: C=27.40±25.51	**KOOS Function in ADL (/100):** **I=74.1±15.1** **Combined mean and SD for C1 and C2:** **C=65.93±21.37** KOOS Function in SR (/100): I=54.3±20.2 Combined mean and SD for C1 and C2: C=43.84±32.45LEFS(/80) Self-reported physical function: I=53.7±12.1 Combined mean and SD for C1 and C2: C=42.32±16.76	None	12 weeks	C1=1 (Due to an unrelated health diagnosis)
Zacharia, 2018	WOMAC: I=2.1±1.6 C=2.1±1.1	TFP: I=65.6±10.5 C=71.9±7.7 **WOMAC:** **I=3.7±3.9** **C=3.9±2.8**	NR	8 weeks	NR
McCaffrey, 2019	WOMAC: I=4.4±2.1 C=4.4±2.4	WOMAC: I=17.4±14.4 C=14.9±13.6	None	8 weeks	None
Vaghela, 2020	WOMAC: I=4.32±1.93 C=7.3±2.13	WOMAC: I=13.79±5.52 C=19.17±7.02	NR	4 weeks	I=2 C=5

Bokaeian, 2021	**VAS:** **I= 35.3±28.7** **Combined mean and SD for C1 and C2:** **C=42.75±24.34** Short WOMAC: I=6.9 ± 6.0 Combined mean and SD for C1 and C2: C=8.39±4.96	2-min walk test: I=144.8±26.1 Combined mean and SD for C1 and C2: C=142.47±18.44	NR	4 weeks	I=2 (a tight work schedule) C1=1 (a tight work schedule)
Park, 2021	Pain interference: Mean and SD cannot be calculated	NR	None	8 weeks	C=19 withdrew (due to personal issues, schedule conflicts, or lack of motivation)
Bennell, 2022	**Walking pain (NRS):** **I=4.2±2.4** **C=4.9±2.4** Overall knee pain (NRS): I=4.0±2.3 C=4.5±2.3 WOMAC: I=5.4±3.4 C= 6.0±3.6	WOMAC: I=15.8±10.7 C=19.3±11.5	n(%)Knee pain: I=3/96 (3.1) C=1/93 (1.1) Upper limb pain: I=4/96 (4.1) C=0/93 (0) Back pain: I=2/96 (2.1) C=1/93 (1.1) Foot pain: I=2/96 (2.1) C=1/93 (1.1) Hip pain: I=2/96 (2.1) C=0/93 (0)	12 weeks	I=8 (unable to contact)I=1 (withdrew from study – lost interest) C=5 (unable to contact) C=3 (withdrew from study – 1 lost interest, 2 reason unknown)

NR: Not reported, VAS: Visual Analogue Scale, SF-36: Short Form 36, NRS: Numeric Rating Scale, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index , SPPB: Short Physical Performance Battery, TUG: Timed Up and Go, ADL: Activities of Daily Living, KOS-ADL: Knee Outcome Survey-Activities of Daily Living, SR: Sports and Recreation, TFP: Total Physical Functional Performance

Note: Where multiple scales have been used, data used for meta-analysis have been represented in **bold** style

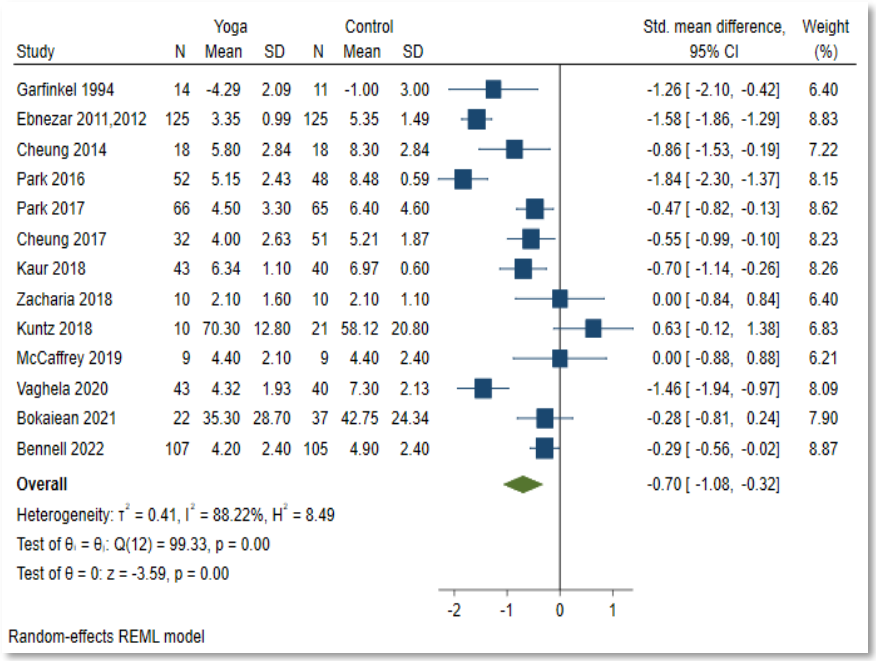


Figure 7 Forest plot for yoga vs comparator (pain). N, sample size; SD, standard deviation; CI, confidence interval

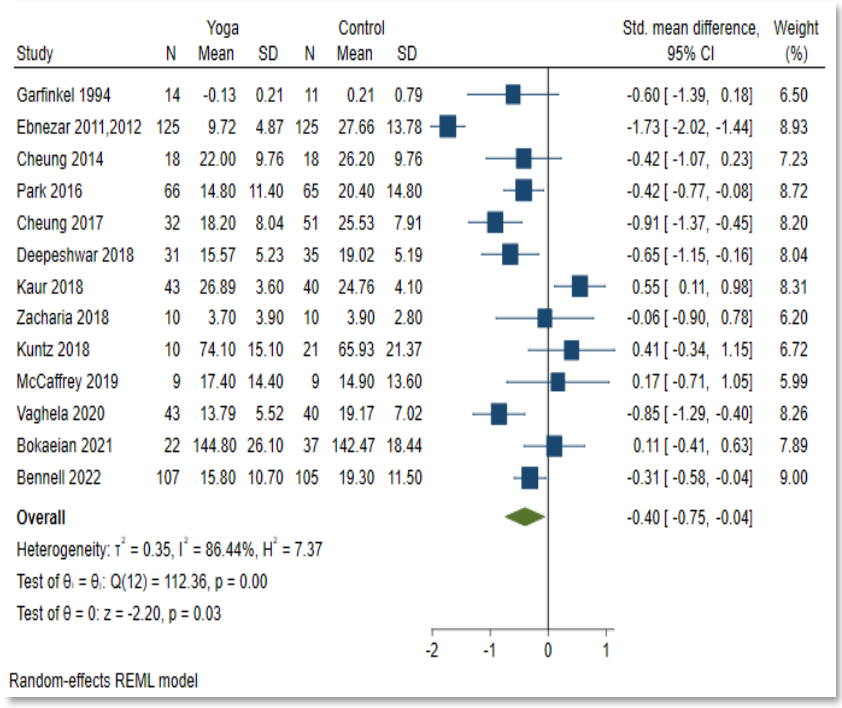


Figure 8 Forest plot for yoga vs comparator (function). N, sample size; SD, standard deviation; CI, confidence interval

Yoga interventions in nine (out of 13) studies were effective in reducing pain (six in knees[213-215,216,218,222,226,229], two in lower extremities[217,220], and one in hand[212]). Yoga interventions in six (out of 13) studies were effective in improving function (five in knees[213-215,218,221,226,229]) and one in the lower extremity[220]. Overall, 10 (out of 14) interventions were effective in reducing pain and/or improving function.[212,213-215,216-218,220-222,226,229]

2.9.6 Content, structure, and delivery characteristics of effective yoga interventions for pain and/or function

Notably, six of 10 effective interventions had centre-based (supervised, group) sessions with additional home-based (unsupervised, individual) sessions[213-215,216-218,220,222], two interventions were completely centre-based[212,221] and one home-based[229]. Of the two completely centre-based interventions, one was supervised[212] and supervision details were unclear in the other[221]. One study did not provide any details on intervention delivery[226]. The content of effective yoga interventions was heterogeneous and included 34 different yogic poses (asana;12 sitting, 10 standing, eight supine, and four prone), eight breathing practices (pranayama), and three meditation (dhyana) and relaxation practices. Eight of 10 effective interventions reported the major components of yoga used; all included asana, and

seven also incorporated pranayama and/or dhyana and relaxation practices. Three of the 10 interventions included all of these three major components of yoga[213-215,217,221], three consisted of asana and dhyana and relaxation practices[216,218,229], one included asana and pranayama[212], and one included only asana[226]. The majority of these studies were not specific about the exact yoga style, except for three, which mentioned Hatha yoga.[216,218,220] Interventions that included all three major components of yoga reported the time allocated to each component.[213-215,217,221] The median time allocated to asana was around 19 minutes (IQR 10-25 minutes), pranayama was around 10 minutes (IQR 3-32 minutes), and dhyana and relaxation practice were around 12 minutes (IQR 10-82 minutes). Some of the common practices were Tadasana (palm tree pose)[213-215,217,218,226], Virabhadrasana 1&2 (warrior pose)[216-218,226], Nadishuddhi pranayama (alternate nostril breathing)[213-215,221], and Nadanusandhana (A-U-M Kara chanting)[213-215,221]. Table 12 details the various yoga practices (along with their Sanskrit and English names) effective for pain and/or function.[230,231]

The median duration of centre-based sessions was eight weeks (IQR 8-12 weeks), and each session was around 53 minutes (IQR 45-60 minutes), and these sessions were mostly delivered once a week (reported in 4 of 8

interventions).[212,213-215,216,218] Where reported (in four of seven interventions)[213-215,216,218,229], the median duration of home-based sessions was 10 weeks (IQR 8-12 weeks) and each session was around 30 minutes (IQR 29-30 minutes), and these sessions were instructed to practise four times a week[216,218]. One intervention, which provided no details on whether it was centre- or home-based, reported session duration and frequency, i.e., 30 minutes thrice a week for four weeks[226]. Three of eight centre-based sessions specifically reported that lectures and counselling on yoga for osteoarthritis, educational materials with written instructions, peer support through group discussion and question-and-answer sessions were used to deliver the intervention.[212,213-215,221]

To address participants' needs (e.g., physical limitations), certain yogic poses were adapted in four of 10 interventions, e.g., by using blocks, straps, blankets, and chairs.[216-218,220] Where reported (six of seven interventions), home-based sessions were delivered by providing written documents with pictures[216-218,220,222] and yoga videos (including demonstrations of modified yoga postures to meet individual needs)[229] to the participants. Strategies were used to monitor and improve adherence to yoga practice at home in six of seven interventions, e.g., sharing self-recorded yoga

diaries/log sheets, self-recorded yoga videos (documenting home practice details) with the trial team, and reminding and motivating participants, e.g., through telephone calls and emails.[213-215,216,218,220,229] Participants were encouraged to practice yoga in the long term in two of 10 interventions.[220,229]

Table 12 Yoga practices used in interventions that were effective for pain and/or function.

Asana				**Pranayama**			**Dhyana and Relaxation practice**		
Sanskrit name	**English name**	**Broad category of yogic pose (standing, sitting, prone, supine)**	**Effective studies reporting use of the asana for pain and/or function**	**Sanskrit name**	**English name**	**Effective studies reporting use of the pranayama for pain and/or function**	**Sanskrit name**	**English Name**	**Effective studies reporting use of the dhyana and relaxation practice for pain and/or function**
Parvatasana	Mountain pose	Sitting pose	Pain[212]	Nadishuddhi pranayama	Alternate nostril breathing	Pain[213-215] Function[213-215,221]	Nadanusandhan a	OM meditation/ A,U,M and A-U-M Kara chanting	Pain[213-215] Function[213-215,221]
Tadasana	Palm tree pose	Standing pose	Pain[213-215,217,218,226] Function[213-215,218,226]	Vibhagıya pranayama	Sectional breathing	Function[221]	Savasana	Corpse pose	Function[221]
Ardha kati chakrasana	Half waist wheel Pose	Standing pose	Pain[213-215] Function[213-215]	Brahamarı pranayama	Bee breathing	Function[221]	Salamba savasana	Supported corpse pose	Function[229]

Ardha chakrasana	Half wheel pose	Standing pose	Pain[213-215] Function[213-215]	Bhastrika pranayama	Bellows breathing	Function[221]	*NR*	*Cyclic meditation*	*Function*[221]
Prasarita padahastasana	Wide-legged forward bend pose	Standing pose	Pain[213-215,229] Function[213-215,229]	Sıtali pranayama	Rolling tongue breathing	Function[221]	*NR*	*Mind sound resonance technique*	*Function*[221]
Bhujangasana	Cobra pose	Prone pose	Pain[213-215] Function[213-215,221]	Sitkarı	Folded tongue breathing	Function[221]	*NR*	*Instant relaxation technique*	*Pain*[213-215] *Function*[213-215,221]
Shalabasana	Locust pose	Prone pose	Pain[213-215] Function[213-215,221]	Sadanta	Clenched teeth breathing	Function[221]	*NR*	*Deep relaxation technique*	*Pain*[213-215] *Function*[213-215,221]
Viparita karani	Legs-up-the-wall pose	Supine pose	Pain[213-215] Function[213-215]	Kapalabhati	Skull shining breathing	Function[221]	*NR*	*Quick relaxation technique*	*Pain*[213-215] *Function*[213-215,221]

Dhanurasana	Bow pose	Prone pose	Pain[213-215] Function[213-215]	*NR*	*Hands in and out breathing*	*Function [221]*			
Ardha titali asana	Half butterfly	Sitting pose	Pain[213-215] Function[213-215]	*NR*	*Hands stretch breathing*	*Function [221]*			
Titali asana	Full butterfly	Sitting pose	Pain[213-215] Function[213-215]	*NR*	*Ankle stretch breathing*	*Function [221]*			
NR	*Hip rotations*	*Standing pose*	*Pain[213-215] Function[213-215]*						
Virabhadrasana I	Warrior I pose	Standing pose	Pain[216-218,226] Function[218, 226]						
Virabhadrasana II	Warrior II pose	Standing pose	Pain[216-218,226] Function[218, 226]						
Vrksasana	Tree pose	Standing pose	Pain[216,228] Function[218]						
Utkatasana	Chair pose	Standing pose	Pain[216,218] Function[218]						
Sukhasana	Easy pose	Sitting pose	Pain[216]						

Baddha konasana	Bound angle pose	Sitting pose	Pain[216,226] Function[226]		
Upavistha konasana	Wide-angle seated forward bend pose/ straddle seat	Sitting pose	Pain[216,229]		
Ardha shalabhasana	Half locust pose	Prone pose	Pain[216,218] Function[218]		
Setu bandha sarvangasana	Bridge pose	Supine pose	Pain[216] Function[221]		
Uttanasana	Standing forward bend	Standing pose	Pain[216,218] Function[218]		
NR	*Hamstring stretches (exact asana NR)*	*Sitting pose*	*Pain[216]*		
Supta baddha konasana	Reclining bound	Supine pose	Pain[218] Function[218]		

	angle pose				
Janu sirsanana	Head-to-knee pose	Sitting pose	Pain[218] Function[218]		
NR	*Reclining hamstrings stretch with hip opener with strap*	*Supine pose*	*Pain[218] Function[218]*		
Supta matsyendrasana	Reclining twist	Supine pose	Pain[216,218] Function[218]		
Utthita trikonasana	Extended triangle pose	Standing pose	Pain[226] Function[226]		
Dandasana	Stick pose or staff pose	Sitting pose	Pain[226] Function[226]		
Supta padangustasana	Reclining hand-to-big-toe pose	Supine pose	Pain[226] Function[226]		
Apanasana	Knee to chest pose	Supine pose	Pain[229] Function[229]		

NR	*Leg extensions supported squat*	*Standing pose*	*Pain[229] Function[229]*		
Paschimottasana	Seated forward bend	Sitting pose	Pain[229] Function[221, 229]		
Bhunamanasana	Earth salutation pose	Sitting pose	Function[221]		
NR	*Straddle seat prep standing forward lunge*	*Standing pose*	*Pain[229] Function[229]*		
Anantasana/ Uttanapadasana	Leg lifts	Supine pose	Pain[229] Function[229]		
NR	*Hip lifts*	*Supine pose*	*Pain[229] Function[229]*		
NR	*Marching one leg balance*	*Sitting/standing Pose*	*Pain[229] Function[229]*		
NR	*Wide leg side bend*	*Standing pose*	*Pain[229] Function[229]*		
Skandasana	Standing side lunge	Sitting pose	Pain[229] Function[229]		
Vakrasana	Twisted pose	Sitting pose	Pain[229] Function[229]		

Markatasana	Lumbar stretch pose	Supine pose	Function[229]		

NR: Not reported **Standing pose:** yoga poses practiced with one or both feet on the ground, and the body more or less upright, **Sitting pose:** Yoga poses practiced in seated position, **Supine pose:** Yoga poses practiced in sleeping position, **Prone pose:** Yoga poses performed with the belly or torso touching or facing the floor.
Note: The English/Sanskrit names of the yoga practices highlighted in *italics* are the names reported by the authors. It was unclear if these were authentic yoga practices as their standard names were not available from the literature and hence were excluded from the counting for the synthesis of content of yoga interventions.

2.9.7 Meta-regression

The covariates examined were session duration (minutes) and intervention duration (weeks). Unlike other potential covariates (e.g., content or delivery format), session and intervention durations were among the most frequently and consistently reported variables across the primary studies, making them feasible for analysis across studies. Further, both are continuous variables, making them suitable for meta-regression compared to categorical variables. Other anticipated categories could not be examined due to inconsistent reporting in included studies and other issues, including categorical variables with sparse data. For example, in the case of the delivery context (venue), only two studies were centre-based and one was home-based. The results of the meta-regression analysis are presented in Table 13, with corresponding bubble plots shown for pain (Figures 9 and 10) and function (Figures 11 and 12).

Table 13 Meta-regression analysis.

Outcome	Covariate	β (Coefficient)	95% confidence interval (CI)	p-value	I^2 (%)
Pain	Session duration (minutes)	0.01	-0.01 to 0.03	0.39	88.59
	Intervention duration (weeks)	0.01	–0.07 to 0.09	0.81	89.19
Function	Session duration (minutes)	-0.0001	-0.01 to 0.01	0.97	87.55
	Intervention duration (weeks)	0.04	-0.03 to 0.10	0.25	85.98

β shows how much the effect size changes with each unit increase in the variable. 95% CI is the range where we are 95% sure the true value lies. The p-value tells us if the change is statistically meaningful. I^2 (%) shows how much of the differences between studies are due to real variation rather than chance.

1. Pain outcome

Session duration: A weak, non-significant positive association was observed (β = 0.01, 95% CI: –0.01 to 0.03, p = 0.39, I^2 = 88.59%). This suggests that longer sessions might be linked to slightly less pain reduction, although the result is inconclusive due to high heterogeneity.

Intervention duration: Similarly, a weak and non-significant positive association (β = 0.01, 95% CI: –0.07 to 0.09, p = 0.81, I^2 = 89.19%) indicates no clear benefit from longer interventions in reducing pain, although the heterogeneity is high.

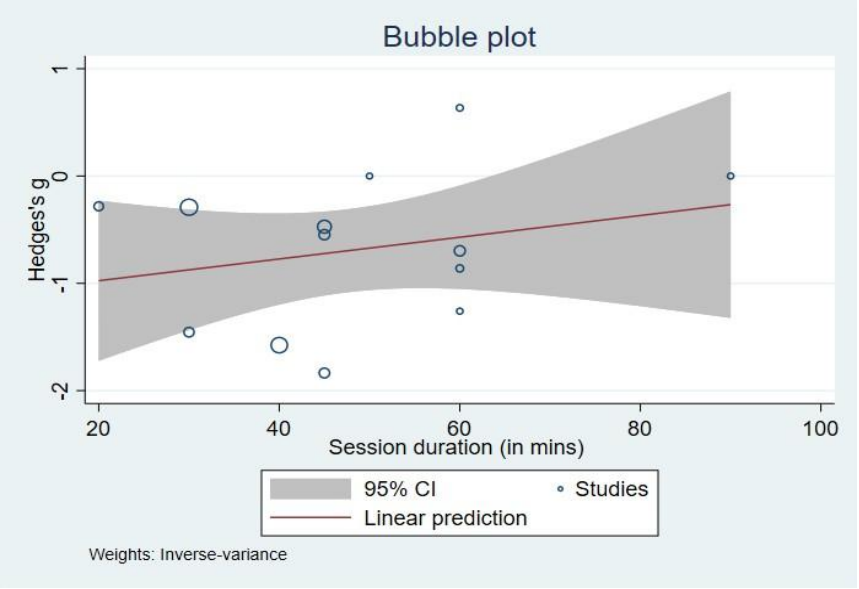


Figure 9 Bubble plot showing the association between session duration (minutes) and effect size (SMD) for the pain outcome.

Each bubble represents an individual study, with bubble size proportional to the inverse variance (i.e., precision) of the effect estimate. The x-axis shows session duration, and the y-axis displays the SMD for pain. A fitted regression line illustrates the direction and strength of the association. No statistically significant relationship was observed.

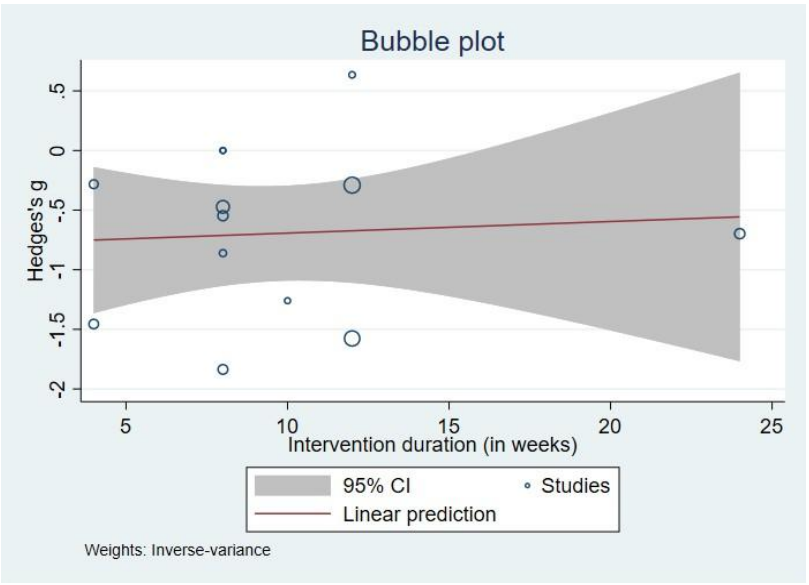


Figure 10 Bubble plot showing the association between intervention duration (weeks) and SMD for pain outcome.

Each bubble represents an individual study, with bubble size proportional to the inverse variance (i.e., precision) of the effect estimate. The x-axis shows session duration, and the y-axis displays the SMD for pain. A fitted regression line illustrates the direction and strength of the association. No statistically significant relationship was observed.

2. Function outcome

***Session duration*:** No association was found (β = –0.0001, 95% CI: – 0.008 to 0.008, p = 0.97, I^2 = 87.55%), indicating that session length does not affect functional improvement, and the heterogeneity is high.

***Intervention duration*:** A weak, non-significant positive association (β = 0.04, 95% CI: –0.03 to 0.10, p = 0.25, I^2 = 85.98%) suggests a possible but uncertain trend toward better function with longer interventions, noted with high heterogeneity.

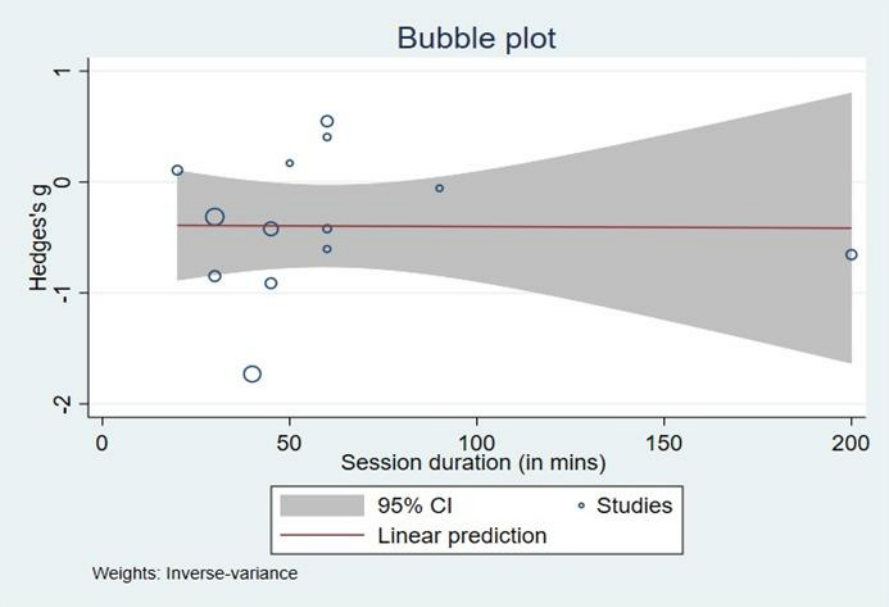


Figure 11 Bubble plot showing the association between session duration (minutes) and SMD for function outcome.
Each bubble represents an individual study, with bubble size proportional to the inverse variance (i.e., precision) of the effect estimate. The x-axis shows session duration and the y-axis displays the SMD for function. A fitted regression line illustrates the direction and strength of the association. No statistically significant relationship was observed.

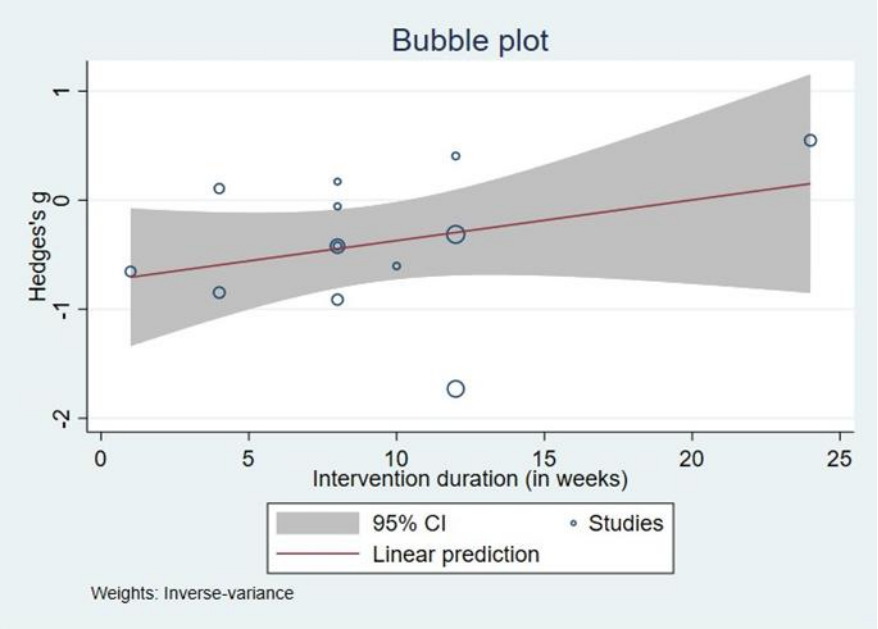


Figure 12 Bubble plot showing the association between intervention duration (weeks) and SMD for function outcome.
Each bubble represents an individual study, with bubble size proportional to the inverse variance (i.e., precision) of the effect estimate. The x-axis shows intervention duration, and the y-axis displays the SMD for function. A fitted regression line illustrates the direction and strength of the association. No statistically significant relationship was observed.

Overall, associations between session and intervention duration and the Outcomes were weak and statistically nonsignificant. For pain, the small positive coefficients suggest that longer durations may be linked to less pain relief, though clinical significance is questionable. For function, the results were inconclusive. Substantial heterogeneity (I^2 > 85%) limits confidence in these findings.[197]

2.10 Discussion

2.10.1 Summary of main findings

This systematic review found beneficial effects of yoga as a complementary approach on two major outcomes of osteoarthritis, i.e., pain and function, as also reported in previous reviews and meta-analyses.[173,174] However, this review is novel as it aims to identify and synthesise key features (content, structure, and delivery characteristics) of effective yoga interventions. Although the components of effective yoga interventions were heterogeneous, some commonalities were identified. A majority of them involved participants attending yoga at a centre for supervised group sessions, once a week for a sustained period. Most also involved individual yoga practice at home, which was unsupervised, several times a week between centre-based sessions. These interventions generally incorporated yogic

poses (asana), but a majority also included other major components, including breathing practices (pranayama) and/or meditation (dhyana) and relaxation practices. Keeping in mind the participants' needs (e.g., knee/hip pain), various modifications were provided to certain yogic poses using props (e.g., a chair as a support for standing poses). The review also indicated ways in which these interventions ensured maximum adherence to yoga among participants, especially to yoga practice at home, through regular contact with the participant or journaling of home practice.

2.10.2 Comparison with the existing literature

Yoga has been recommended by an international osteoarthritis evidence-based clinical guideline developed by the ACR and the AF.[53] This guideline used the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) methodology to rate the quality of the available evidence and to develop the recommendations.[53] The guideline was developed by an expert panel representing the ACR, including rheumatologists, an internist, physical and occupational therapists, and osteoarthritis patients. The guideline "conditionally" recommends the use of yoga for managing symptoms of knee osteoarthritis. The recommendation inferred that yoga

could be used by the patients to manage knee osteoarthritis only after shared decision-making, including a detailed explanation of the benefits and harms of yoga to the patients, in a language and context they understand. However, due to a lack of evidence, no recommendations could be made for managing hand and hip osteoarthritis through yoga.[53] It is important to note that this guideline was based on a generic definition of yoga laid out by the National Center for Complementary and Integrative Health (NCCIH) as "a mind-body practice consisting of physical postures, breathing techniques, and meditation or relaxation".[232] Yoga includes a diverse range of components, so it is important to consider the aspects of yoga that are effective.

2.10.3 Strengths and limitations of the systematic review

To the best of our knowledge, this is the first systematic review to synthesise the content, structure, and delivery characteristics of effective yoga interventions used as a complementary approach for treating major symptoms of osteoarthritis. This review followed a rigorous systematic review methodology, adhering to the JBI and PRISMA guidelines, with independent screening by two reviewers and involvement of a third reviewer to resolve any disagreements.[187,188] A comprehensive search of seventeen

databases was performed without date or language restrictions. Determination of the effectiveness of interventions was standardised across studies by using meta-analysis, before finally the detailed characteristics of potentially effective yoga interventions were synthesised. Despite the extensive search strategy, only 16 studies met the inclusion criteria, and two of these could not be included in the meta-analysis. While inclusion of only RCTs strengthens the internal validity of the review, it may have excluded potentially informative observational or quasi-experimental studies that could offer insights into long-term adherence, safety, and real-world applicability of yoga interventions. Meta-regression analyses indicated that session and intervention duration did not strongly explain variability in treatment effects, but future research could explore these trends. It is important to interpret these findings with caution, as meta-regression is limited by a small number of included studies, small sample sizes and potential ecological fallacy (assuming that what is true for a group is also true for each person in that group), relying on study-level rather than individual-level data.[197] The limited number of included studies may have reduced statistical power, making the associations exploratory rather than confirmatory. Nonetheless, the findings provide preliminary evidence that yoga intervention features such as session and

intervention duration may influence pain reduction and function improvement in osteoarthritis treatment. Future research should prioritise well-powered, high-quality RCTs to examine potential dose-response relationships of yoga interventions, including optimal session length, programme duration, and component combinations, to further understand their effects on pain reduction and functional improvement.

2.10.4 Limitations of the included studies and future research directions

Our review highlighted some limitations in the included studies. Some studies had incomplete or unclear information on the time allocated to each component of the yoga intervention. Future RCTs should improve the reporting of this detail, which would help in establishing the aspects of yoga practice that are most beneficial for improving osteoarthritis symptoms and, therefore, where the emphasis for future yoga-based interventions should lie. Most studies did not describe the qualifications of the yoga providers; instead only described the yoga providers as certified, experienced, or trained. Where yoga provider qualifications were reported in detail, there was no description of the yoga providers' training to deliver the specific intervention protocol. The expertise of yoga providers and their training

in the intervention protocol are likely to be essential to the effectiveness of the intervention and in ensuring the fidelity and safety of the intervention.[233,234] Thus, future RCTs should ensure adequate reporting of the training details of the yoga providers. In terms of safety, a majority of the studies did not explicitly report adverse events related to yoga. This issue should be addressed and reporting should be improved in future RCTs to indicate their safety.

Most included studies were based in the USA, predominantly included females and reported on knee osteoarthritis. These factors potentially limit the generalisability of our findings, including those in different healthcare systems, cultural contexts, and socioeconomic settings. Existing evidence has shown a higher uptake of yoga among women as compared to men.[136] Although osteoarthritis is more common in women, it also affects men; hence, the underrepresentation of male participants reduces the generalisability of the evidence. So, it is important to explore the possible barriers to yoga practice among men (e.g., gender-based perceptions and their preference for other forms of physical activity) and take some initiatives (e.g., men-only yoga classes) to promote yoga among men for osteoarthritis in future RCTs.[235] Future studies should recruit more diverse populations across

different countries, age groups, and sexes to better understand the global applicability of yoga as a complementary approach for osteoarthritis treatment. Lastly, most included studies involved relatively short-term follow-up, and only two of our included studies reported on encouraging participants to continue yoga practice. For a chronic condition like osteoarthritis, it will be important to explore whether yoga practice and its effects are sustained in the longer term. Despite the low quality and heterogeneity of included studies, our findings suggest yoga interventions might be effective as a complementary approach in treating osteoarthritis symptoms and highlight the key characteristics of such effective yoga interventions.

Supervised yoga practice in groups at a centre seemed to be one of the most consistent characteristics in the studies included in this review. This might reflect the importance of creating a community for yoga practice, given that most people with osteoarthritis are older and may be socially isolated.[236] Older participants generally tend to be interested and adherent to yoga classes (at a centre)[237], which may also be why centre-based yoga sessions are an important feature of yoga practice. Participant adherence to yoga interventions likely plays an important role in their effectiveness for treating osteoarthritis symptoms.[238] However, most of the

included studies did not report the intervention development process, making it unclear whether safety, acceptability, and other design aspects were carefully considered. Additionally, important intervention details, such as adherence and home practice, were often inadequately described, making it difficult to replicate successful interventions. Although the level of adherence was generally not reported, many studies included in the review mentioned using strategies to promote it, such as self-reporting of home practice and ensuring regular contact with the participants. To further improve adherence to mind-body interventions such as yoga, some strategies, including providing reminders, following up with the individual to ensure regular yoga practice, and tailoring the practice to individual needs (e.g., modifying yogic poses), have been identified.[239] Further, it will be important to explore how yoga interventions might be implemented and integrated as a complementary approach within the orthopaedic healthcare system.[240] Hence, future research should aim to develop a yoga programme for managing osteoarthritis by using the synthesised findings from this review. This is likely to require the input of a variety of stakeholders, including osteoarthritis patients, yoga providers, and orthopaedic doctors, to address the potential

challenges and to consider the evidence base for its effective and safe incorporation, by using Delphi or similar methods.

2.11 Conclusion

Despite methodological limitations and heterogeneity among the included studies, the evidence suggests that yoga, when delivered alongside pharmacological and/or non-pharmacological treatments, can reduce pain and improve function in people with osteoarthritis. Effective interventions generally combined centre-based (supervised) and home-based (unsupervised) practice, incorporated a range of yogic poses, and included breathing, meditation, or relaxation components. However, most included studies had small sample sizes, were short-term, and were conducted in high-income countries, which limits the generalisability of findings. These findings provide preliminary support for yoga as a complementary approach to osteoarthritis treatment, though a high-quality long-term RCT should be conducted using the synthesised key characteristics of previous effective yoga interventions, as identified by this review.

Having established the key features of effective yoga interventions for osteoarthritis, the next chapter extends this systematic research approach to rheumatoid arthritis,

enabling comparison of key characteristics of effective yoga interventions across the two most prevalent forms of arthritis in the UK.

Chapter Three: Key characteristics of effective yoga interventions in addition to conventional medicine for rheumatoid arthritis: a systematic review and meta-analysis

3.1 Introduction

Rheumatoid arthritis, introduced in Chapter One, is the most common autoimmune inflammatory arthritis, characterised by warm, swollen, painful, and stiff joints, and can result in poor joint function.[2,77] In 2020, the number of rheumatoid arthritis prevalent cases worldwide was estimated to be 17.6 million, and the number of cases is projected to reach around 31.7 million by 2050.[241] Given the significant impact of rheumatoid arthritis on individuals, there is a need for advancements in treatment alternatives to improve their condition and alleviate the burden on healthcare systems.[242]

The existing guidelines suggest a "treat-to-target" approach for rheumatoid arthritis treatment, which aims to achieve a target (i.e., remission or reduced disease activity) through treatment options.[106-108] Prolonged use of these medications may have adverse effects (e.g., gastrointestinal distress) and economic burdens on individuals and the healthcare system.[110,111,243] Recently, there has been a growing interest in complementary approaches for treating inflammatory rheumatic conditions.[244-246] Further, the NICE guideline also recommends that complementary approaches, in addition to conventional treatment, could be beneficial in rheumatoid arthritis.[108]

As discussed in Chapter 1, yoga, a popular complementary health approach encompassing physical postures, breathing practices, and meditation and relaxation practices, might be helpful for people with rheumatoid arthritis.[126,247-249] The ACR and the EULAR guidelines recommend using additional interventions (e.g., mind-body exercises such as yoga) in conjunction with standard medications for rheumatoid arthritis treatment.[113,114]

Some systematic reviews that included randomised and non-randomised studies have reported beneficial effects of yoga interventions on one or more rheumatoid arthritis outcomes, such as lower disease activity scores, pain relief, and functional improvement.[169,170,177-181] A recent systematic review and meta-analysis, which included both randomised and non-randomised studies, found a reduction in disease activity score and improved physical function in those receiving yoga intervention in addition to standard medical treatment compared to no additional intervention.[181] As outlined in chapter two, content, structure, and delivery characteristics are key features of a yoga intervention.[186] Synthesising these key features of effective interventions is crucial in developing a high- quality yoga programme aimed at improving rheumatoid arthritis outcomes. While some of

these reviews have examined effectiveness of yoga on outcomes of rheumatoid arthritis and described characteristics of yoga interventions used in addition to conventional medicine for rheumatoid arthritis, they did not synthesise their key features.[169,170,177-181] Therefore, based on the methodology established in Chapter 2, this chapter presents a systematic review and meta-analysis aimed to meet this gap in the literature by synthesising the content, structure, and delivery characteristics of effective yoga interventions in addition to conventional medicine for rheumatoid arthritis. These findings could be used to develop a comprehensive evidence-based yoga intervention for treating rheumatoid arthritis for wider implementation.

Review question: What are the content, structure, and delivery characteristics of yoga interventions for rheumatoid arthritis in addition to conventional medicine that are effective in improving disease activity score and/or pain and/or function, compared with usual care or other non-yoga interventions?

3.2 Methods

This systematic review adhered to the JBI methodology for systematic reviews of effectiveness and the PRISMA guidelines.[187,188] This review was conducted according to an

a priori published protocol[250] and registered with PROSPERO (registration number - CRD42022320337).

3.3 Inclusion criteria

Population: Studies conducted among adults (aged ≥ 18 years) diagnosed with rheumatoid arthritis were included. No restrictions were applied regarding the diagnostic criteria of rheumatoid arthritis, including diagnosis based on physical examination, blood tests, and/or joint scans (e.g., diagnosis based on the ACR criteria or physician-diagnosed).

Intervention: Studies that assessed yoga interventions in addition to conventional medicine for rheumatoid arthritis, including at least one of the major components of yoga, namely, asana (yogic poses), pranayama (breathing practices), and dhyana (meditation) and relaxation practices, were included. There were no restrictions on the yoga style and its session length, frequency, duration, and delivery mode.

Comparator: Studies comparing yoga with no additional intervention (i.e., participants received only conventional medicine for rheumatoid arthritis), sham intervention, or non-pharmaceutical intervention (e.g., educational

intervention) was included. Studies with head-to-head comparisons of two or more yoga interventions (i.e., different in terms of content, structure, or delivery characteristics) were excluded.

Outcome: Studies that assessed at least one of the main outcomes of rheumatoid arthritis, i.e., disease activity score (DAS), pain, or function, were included.[108,251,252] Studies reporting DAS28 scores and other composite scores used to measure disease activity were eligible.[87,120] Disease activity trajectory is commonly monitored using the DAS28 score, which includes objective measures assessed by the clinician (i.e., swollen joint count (SJCs) and the inflammatory markers measured in blood tests (either ESR or CRP level) and the subjective patient-reported measures (i.e., total joint count (TJCs), and global health as assessed by using a visual analogue scale of patient-reported disease activity (VAS GH)).[118] The patient-reported or subjective measures within the DAS28 composite score represent the patient global assessment (PGA) and are more susceptible to individual-level variation.[253] Any scale used for assessing pain (e.g., VAS) and function (e.g., AIMS) was eligible.[178] Radiographic outcomes are not considered core outcomes and, therefore, were excluded.[251]

Study design: Considering the hierarchy of study designs, only RCTs were included. Non-randomised pilot or feasibility trials were excluded.

3.4 Data sources and search strategies

The following 13 databases were searched to find published studies from their inception dates to 16 November 2023: MEDLINE (Ovid), EMBASE (Ovid), PsycInfo (Ovid), CINAHL (EBSCOHost), Cochrane Central Register of Controlled Trials (CENTRAL), Allied and Complementary Medicine (AMED) (Ovid), SPORTDiscus (EBSCOhost), Web of Science (Clarivate Analytics), Turning Research Into Practice (TRIP), AYUSH Research Portal, A Bibliography of Indian Medicine (ABIM), CAM-QUEST, and Physiotherapy Evidence Database (PeDro). Unpublished studies were also searched from their inception dates to 16 November 2023 using OpenGrey (from 1997), EthOS (from 1925), ProQuest Dissertations and Theses (from 1980), and DART-Europe-e-theses portal (from 1999). No language restrictions were applied. The search strategies were developed in consultation with a research librarian at the University of Nottingham (Appendix 3), based on the search strategies in the following: “yoga” component based on a relevant systematic review[193], “rheumatoid arthritis” component based on the UK’s NICE guideline on

rheumatoid arthritis[254] and a Cochrane systematic review on rheumatoid arthritis[255], and "RCT" component using pre-designed search filters[197,199,256]. The reference lists of all the included studies and relevant previous systematic reviews were screened for additional studies.

3.5 Study screening and selection

Retrieved articles from the searches were uploaded to EndNote X9 (Clarivate Analytics, PA, USA)[200], and after duplicate removal, the remaining citations were uploaded onto Rayyan (Qatar Computing Research Institute [Data Analytics], Doha, Qatar)[201], to facilitate the title and abstract screening process using the inclusion criteria. Studies identified as potentially eligible or those without an abstract had their full text retrieved. The full texts of the studies were assessed for eligibility, and those that did not meet the inclusion criteria were excluded, citing reasons. Any disagreements that arose between the two reviewers were resolved through discussion. If a consensus was not reached, then a third reviewer was involved.

3.6 Assessment of methodological quality

The included studies were critically assessed using the standardised JBI critical appraisal tool for RCTs.[187] This tool has 13 criteria that can be scored as being met (Y), not

met (N), unclear (U) or not applicable (N/A). One of the criteria was about blinding of intervention deliverers, which was not possible with yoga interventions and was scored as not applicable. Two reviewers independently assessed each criterion and commented on it. Any disagreements that arose between them were resolved through discussion. If a consensus was not reached, then a third reviewer was involved. Regardless of methodological quality, all studies underwent data extraction and synthesis.

3.7 Data extraction

Data was extracted using a pre-developed and pre-tested data extraction form by two independent reviewers. If a consensus was not reached through discussion, a third reviewer was consulted. The extracted data included the following characteristics of studies: author and year of publication, country, major inclusion criteria (including diagnosis), population characteristics (age, sex, duration of rheumatoid arthritis, any other therapy or medication for rheumatoid arthritis), sample size, intervention and comparator details, study outcomes (disease activity score, pain, function, and adverse events), dropouts/withdrawals/discontinued interventions due to adverse events, and data extraction time point (in weeks). In addition, the characteristics of yoga interventions were

extracted: intervention development, intervention duration, content (e.g., asana, pranayama, and dhyana and relaxation practices), structure (e.g., session duration and frequency), and delivery characteristics (location, settings, characteristics of yoga providers, and strategies used to monitor and increase adherence to interventions).

The authors extracted the end-of-intervention data (mean and SD) for all the outcomes - disease activity score, pain, and function.[251,255] Where this time point was not reported, data from the time point closest to the end of the intervention were extracted. ITT data were preferred compared to per-protocol data.[202,203] Post-intervention data were extracted in preference to change from baseline data (i.e., post-intervention score – baseline score). Percentage change from baseline was not extracted, as it is highly sensitive to change in variance, and it also fails to protect from baseline imbalances, leading to non-normally distributed outcome data.[204] Disease activity scores, pain, and function are reported as continuous data, so the mean and SD were extracted. Where no SDs were available, they were calculated from SE, CIs, or IQRs, using the formula from the Cochrane Handbook.[205] Where mean and SD for more than one intervention or control group were reported, the combined sample size, mean, and SD were calculated

using the formulae in the Cochrane Handbook.[205] Yoga-related adverse events, where reported, were extracted. In case of unclear data, the corresponding authors were contacted by email (twice) to obtain the relevant data.

3.8 Data synthesis

Considering the errors in how authors analyse and report yoga interventions to be effective in studies (e.g., conducting pre-post analysis of outcomes within study arms but no comparative analysis between study arms), meta-analyses were conducted for yoga in addition to conventional medicine vs. any comparator to determine the true effectiveness of each included yoga intervention for all the outcomes – disease activity score, pain, and function. Random-effects meta-analyses using Review Manager 5.4.1 (Copenhagen, The Nordic Cochrane Centre, The Cochrane Collaboration) were conducted to identify effective yoga interventions.[206] Random-effects meta-analyses were conducted due to the heterogeneous nature of the yoga interventions.[211] Since the included studies used different scales to report the outcomes, SMDs with 95% CIs were estimated. It should be noted that calculating SMDs does not correct for differences in the direction of scales, i.e., when some scales increase with disease severity, whereas others decrease.[205] In such cases, the extracted mean values of

scales in contrary directions were multiplied by (-1) to ensure consistency in the direction of scales, and SDs were used as reported.[205] Statistical heterogeneity was assessed using the I^2 statistic, with $I^2 > 50\%$ indicating substantial heterogeneity.[205]

Subsequently, the content, structure, and delivery characteristics of the effective yoga interventions were narratively synthesised using tables and text. A narrative synthesis of the yoga interventions identified as effective from the meta-analyses for disease activity score, pain, and function was conducted, focusing on the content, structure, and delivery characteristics of the yoga interventions. Commonalities and differences of the yoga interventions effective for either or both outcomes were also summarised. The Sanskrit and English names of all the yogic components used in the effective interventions and the number of RCTs using these practices were tabulated. To examine whether study-level characteristics, such as the duration or frequency of yoga sessions, were associated with variations in treatment outcomes of rheumatoid arthritis (i.e., reduced DAS scores, pain reduction and functional improvement) in rheumatoid arthritis, a random-effects meta-regression analysis was planned using STATA

17, provided that at least 10 studies could be included in the meta-analysis.[211]

3.9 Assessing the certainty of the evidence

Unlike Chapter Two, this chapter incorporates the GRADE approach to assess the certainty of evidence for each outcome.[211,257] The inclusion of GRADE in this chapter reflects a progression in my understanding and application of systematic review methodology and aims to enhance the transparency and reliability of the findings. The findings were initially ranked as high and downgraded to moderate, low, or very low if there was evidence of the following: risk of bias, inconsistency of results, indirectness of evidence, imprecision, and/or publication bias.[257] In the risk of bias domain, the following were considered for downgrading: lack of allocation concealment (no to Q2 in the JBI critical appraisal checklist for RCTs), lack of blinding (no to Q4,5,7), attrition bias (no to Q11), and if there was selective outcome reporting. If an issue out of these four was present in most studies (i.e., >50%), it was downgraded by one level. If more than one issue was present, it was downgraded by two levels. In the inconsistency of results domain, if the statistical heterogeneity (i.e., I^2 statistic) was 75%-89%, it was downgraded by one level. If the I^2 statistic was ≥90%, it was downgraded by two levels. In the imprecision domain,

if the total sample size was 100 to <400, it was downgraded by one level. If the total sample size was <100, it was downgraded by two levels. If the total sample size was ≥400 with a wide CI and not earlier downgraded for inconsistency, it was downgraded by one level. Indirectness of evidence was assessed based on the relevance of populations, interventions, comparators, and outcomes to the research question. Publication bias was planned to be assessed using funnel plots if at least 10 studies were available for a given outcome.[211]

3.10 Results

3.10.1 Study selection

2405 records were identified through the literature search. After removing duplicates and title and abstract screening, 25 articles were retrieved for full-text screening. Nine articles were included in this systematic review, representing five studies (RCTs).[258-266] Five articles described the same RCT, providing data on different outcomes and, therefore, were included as a single study in this review.[260-264] The study selection process is detailed in the PRISMA flowchart (Figure 13). No additional articles were identified from citation searching. The list of articles excluded following the full-text review is presented in Appendix 4. During screening, no studies were found that used yoga as the sole

intervention (i.e., without standard medical treatment) or as part of other multimodal interventions.

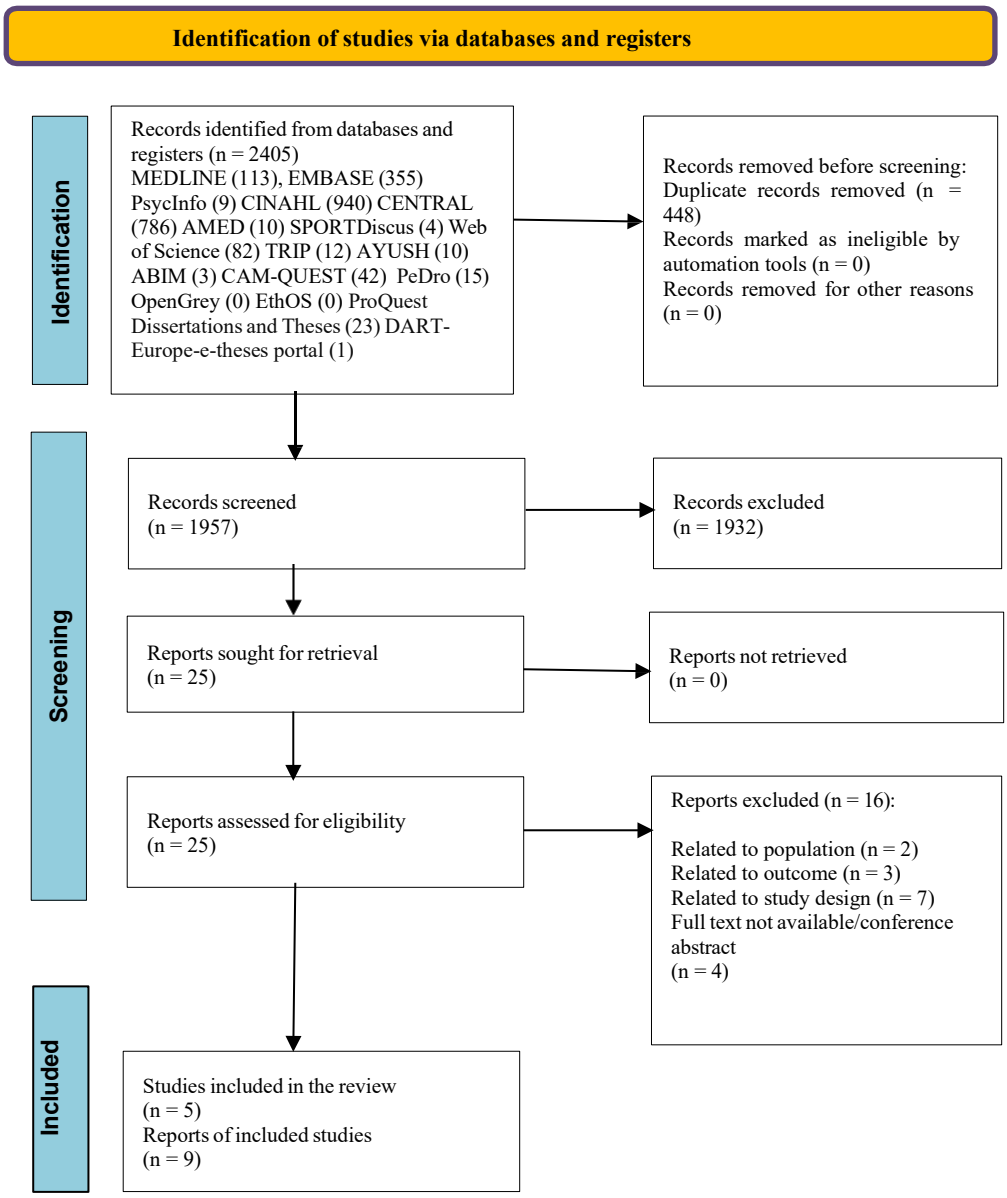


Figure 13 PRISMA flowchart for included studies from searches of databases and registers only.

3.10.2 Description of the included studies

Five studies met the inclusion criteria, and 718 participants were included.[258,259,260-264,265,266] Three studies were conducted in India (n = 635)[258,260-264,265] and one each in New Zealand (n = 26)[259] and Croatia (n = 57)[266]. The number of enrolled participants with rheumatoid arthritis ranged from 26 to 143. Studies recruited participants aged 18-75 years, with mean ages ranging from 35 years[258] to 55 years[266]. Of the 718 participants, most were women (n = 598; 83%). The mean duration of symptoms ranged from <3 years[265] to 12 years (SD 10)[259]. Where mentioned (three of five studies), participants had no previous experience of yoga practice[265,266], whereas 31% of participants had practised yoga previously in another study[259]. Where reported (two of five studies), the mean disease severity (SD) was 2.60 (0.85)[266] and 4.89 (0.81)[260-264], low and moderate, respectively, as per the DAS28ESR criteria. All studies reported prescribed medication use in the yoga and control groups.[258,259,260-264,265,266] Where reported (two of five studies), the most commonly used medications were DMARDs among 77%[266] and 92%[259], glucocorticoids among 30%[266] and 46%[259], NSAIDs among 9%[266] and 23%[259], and biologic therapies among 18%[266] and 12%[259] of the overall participants. Some of the less frequently utilised medications by participants (reported in two of five studies)

included MTX monotherapy (100%)[260-264], MTX in

combination with other DMARDs (33%)[260-264], bone-sparing therapies (31%)[259], and analgesics (31%)[259]. The comparator groups varied from usual care, which included standard medication prescribed by a rheumatologist and following a daily routine with no involvement of an exercise regimen for the intervention duration[259,260-264], wait-listed controls, i.e., practising the yoga intervention after 1.5 months[258] and three months[265] after the beginning of the intervention, to education involving a lecture by a rheumatologist on arthritis-related topics facilitated by participant discussion[266]. The overview of characteristics of the included studies and yoga intervention details of the included RCTs are reported in Tables 14 and 15, respectively.

Table 14 Characteristics of included studies.

Author and year	Country	Major inclusion criteria, including diagnosis	Population characteristics				Sample size (n)	Intervention (I) (Yoga in addition to standard medical treatment)	Comparator (C) (other interventions in addition to standard medical treatment)
			Age in years (M ± SD)	Sex (F/M)	Duration of RA (years/months), (M ± SD)	Any other therapy/medication for RA			
Singh, 2011	India	-Ages 23-48 years -RA patients -Diagnosis: NR	I=35.07 ±7.33 C=34.65 ±7.30	Both sexes, 56/24	I=11.52 ± 7.03 C=12.15 ± 7.02	Usual medications for RA (NS)	80 (I = 40, C = 40)	Yoga (including cleaning practices and yogic diet)	Wait-listed control
Ward, 2018	New Zealand	-Ages ≥18 years -Average self-reported pain over the previous month ≥3 on a 10-point NRS -Average self-reported sleep disturbance over the last month -Diagnosis: by a physician using ACR/EULAR 2010 classification criteria	All=54.00 ± 11.00 I=50.00 ± 12.00 C=59.00 ± 8.00	Both sexes, I:13/0 C:12/1	All=12.00 ± 10.00 I=11.00 ± 10.00 C=12.00 ± 11.00	DMARDs NSAIDs Biologics therapies Bone-sparing therapies Glucocorticoids Analgesics	26 (I=13, C=13)	Yoga	No additional intervention

Gautam, 2019	India	-Ages 18–60 years -Routine medical treatment, including DMARDs≥ 6 months -Diagnosis: ACR/EULAR 2010 classification criteria	I=45.70 ± 1.60 C=42.10 ± 1.70	Both sexes, I:29/7, C:27/9	I=6.32 ± 0.80 C=5.61 ± 0.70	NR	72 (I=36, C=36)	Yoga	No additional intervention
Gautam, 2020			I=45.10 ± 8.70 C=43.40 ± 9.30	Both sexes, I:28/5, C:25/8	NR	NR	66 (I=33, C=33)		
Gautam, 2021			I=45.60 ± 7.90 C=44.50 ±7.70	Both sexes, I:29/6, C:27/8	I=6.50 ± 4.6 C=5.60 ± 4.2	NR	70 (I=35, C=35)		
Gautam, 2022			I=44.63 ± 11.90 C=47.01 ± 12.00	Both sexes, I:62/8, C:56/14	I=6.09 ± 4.20 C=6.10 ± 3.10	MTX monotherapy MTX plus other DMARDs	140 (I=70, C=70)		
Gautam, 2023			I=46.0 ± 9.4 C=41.8 ± 9.7	Both sexes, I:26/6, C:23/9	I = 6.6 ± 4.8 C = 5.6 ± 4.4	MTX monotherapy MTX plus other DMARDs	64 (I=32, C=32)		
Ganesan, 2020	India	-Ages-30-60 years -High disease activity (as per DAS 28 criteria -Diagnosis: ACR/EULAR 2010 classification criteria	I=41.33 C=42.59	Both sexes, I:63/5, C:68/7	<3 years	Standard medical treatment	143 (I=68, C=75)	Yoga	Wait-listed control

Pukšić, 2021	Croatia	-Ages 18–75 years -Low to moderate disease activity (DAS28CRP<5.1) -Stable standard pharmacotherapy for ≥3 months - Diagnosis: ACR/EULAR 2010 classification criteria	I=52.90 ± 12.20 C=57.90 ±9.00	Both sexes, I:30/0, C:24/3	I=7.40 ± 6.09 C=8.70 ± 9.20	DMARDs NSAIDs Biologic therapies Glucocorticoids	57 (I=30, C=27)	Yoga	Educational control (lecture by a rheumatologist on arthritis-related topics[a] + participant discussion)

Note: Only yoga-related interventions were mentioned under intervention, and no intervention or any other active interventions were mentioned under comparator. ACR: American College of Rheumatology, EULAR: European Alliance of Associations for Rheumatology, DMARD: disease-modifying antirheumatic drug, NSAID: nonsteroidal anti-inflammatory drug, MTX: methotrexate, DAS: disease activity score, CRP: c-reactive protein, NRS: Numeric Rating Scale, NR: Not reported. [a](e.g. inflammatory process and joints, RA symptoms, comorbidities, therapy and treat-to-target approach, exercise and self-help)

Table 15 Yoga intervention details (content, structure and delivery characteristics) of the included RCTs.

Author and year	Intervention development and duration of intervention	Yoga sessions: content			Yoga sessions: structure (duration and frequency)	Yoga sessions: delivery characteristics (context, instructor, and uptake and adherence)	Extra features
		Asana	**Pranayama**	**Dhyana and relaxation**			
Singh, 2011	Based on ancient yoga texts to improve/alleviate pain, inflammation, stiffness, PR, BP, LC, CRP, and UA; 7 weeks	**Asana - 40 mins** Anti-rheumatic series (Pawanmuktasana/ joint loosening series) for 1st week , Marjari asana (cat pose), Vakranasana (seated spinal twisting), Shashankasana (rabbit pose), Bhujangasana (serpent pose), Shalbhasana (locust pose), Halasana (plough pose)	**Pranayama - 20 mins** Sequential Nadisodhan pranayama (alternate nostril breathing) – 10 mins - 3 rounds, Bhastrika pranayama (bellows breath)-5 mins - 2 rounds, Bhramari pranayama (humming bee breath) - 5 mins - 10 rounds	**Dhyana and relaxation practices - 25 mins** Soham meditation - 8 mins followed by OM meditation - 2 mins - 10 rounds, Instant relaxation with Gayatri mantra - 5 mins, Savasana (corpse pose) – 10 mins	I = 85 mins daily X 7 weeks (excluding Sundays) (~40 days)	-Centre-based group sessions delivered and supervised by a qualified yoga teacher.	Cleansing techniques: Kunjal kriya (stomach cleansing) - twice/week, Jal Neti (nasal cleansing) - thrice/week, queries and feedback - 5 mins

Ward, 2018	NR; 8 weeks	**Asana - 38 mins** Pawanmuktasana 1 (wind release pose) - 10 mins, Supine, seated and standing postures - 28 mins	**Pranayama - 7 mins** Centring and breathing practice - 7 mins	**Dhayana and relaxation practices - 15 mins** Guided relaxation - 15 mins	I = 60 mins/week X 8 weeks	-Centre-based group sessions delivered and supervised by a qualified yoga instructor and class assistant and home-based individual sessions. - Thrice/week home-based yoga practice was encouraged. -Use of props (foam, block, belt etc). -Home-based practice guided via CD.	Check in - 5 mins, introduction to the class lesson and yoga philosophy theme - 5 mins, warm-up practice, closing discussion - 5 mins

Gautam, 2019,2020, 2021,2022, 2023	Based on Patanjali's Ashtanga yoga for joint inflammation; 8 weeks	**Asana - 20 mins** Standing poses - 5 mins Trikonasana (triangle pose, Katichakrasana (waist rotating pose), Tadasana (mountain pose), Virabhadrasana (warrior pose) Sitting poses - 5 mins Gomukhasana (cow face pose), Paschimottanasana (seated forward bend), Shashankasana (hare pose), Vakrasana (spinal twist pose) Prone poses - 5 mins Ek-pada-shalabhasana (locust pose), Bhujangasana (cobra pose), Poorna shalabhasana (full locust pose), Makarasana (crocodile pose) Supine poses- 5 mins Uttanapadasana (intense stretch of legs), Setu bandhasana (bridge pose), Pavanamuktasana	**Pranayama - 20 mins** Kapalbhati kriya (skull-shining breath), Ujjayi breath (diaphragmatic breath), Nadi shodhana (alternate nostril breathing), Bhramari (bee breath)	**Dhayana and relaxation practices - 28 mins** Dhyana (meditation) - 15 mins - Savasana (corpse pose) - 10 mins, Nada anusandhana, OM meditation - 3 mins	I = 68 mins X 5 times/week X 8 weeks	-Centre-based group sessions delivered and supervised by well-qualified yoga instructors. -Adherence was monitored with the participant's diary and yoga teacher's remarks at each visit.	Session preparation instructions - 2 mins, starting prayer - 5 mins, yogic sukshma vyama + yogic sthool vyama – 10 mins, interactive session/self-directed learning - 30 mins, interactive session/self-directed learning - 30 mins, Shanti mantra (closing prayer) - 5 mins -Encouragement for long term yoga.

		(wind-relieving pose), Matsyasana (fish pose)					
Ganesan, 2020	NR; 12 weeks	**Asana - 8 mins** Tadasana (mountain pose), Katichakrasana (lateral arc pose), Konasana (angle pose), Urdhwa hastottanasana (upstretched arms posture), Pavanamuktasana (wind removing pose), Bhujangasana (cobra pose)	**Pranayama – 6 mins** Nadishodhana pranayama (alternate nostril breathing), Chandrabhedi pranayama (left nostril breathing), Bhramari (humming bee breathing)	**Dhyana and relaxation practices - 5 mins** Dhyana (OM meditation), Savasana (corpse pose, palms up)	I = 19 mins X 3 times/week X 12 weeks	-Centre-based group sessions delivered and supervised by qualified and experienced yoga instructors and home-based individual sessions. -Home-based practice was encouraged and monitored by phone calls.	Warm up - 2 mins, Sukshma vyama – 9 mins
Pukšić, 2021	Based on the Yoga in Daily Life system (Level 1 -Sarvahita Asanas) was developed by Indian yoga teacher Vishwaguru Paramhans Sri Swami Maheshwaranda; 12 weeks	**Asana - NR**	**Pranayama - 70 mins** Breathing exercises (included abdominal breathing and consecutively complete yogic breath (utilising abdominal, thoracic and clavicular part of the breath)) - 50–60 mins,	**Dhyana and relaxation practices - 25 mins** Guided relaxation- in a supine position Anantasana (sleeping Vishnu pose) - 5–10 mins, Short relaxation - 5 mins, Self-	I = 95 mins X 2 times/week X 12 weeks	-Centre-based group sessions delivered and supervised by a rheumatologist and qualified yoga instructor. -Pranayama and meditation	-Postures adapted for functional limitations

			Nadi shodhana pranayama (alternate nostril breathing - 10 mins	inquiry meditation – 5-10 mins, closing OM meditation		were performed sitting on exercise balls. -Home practice advised but not formally monitored.	

NR: Not reported (Only the terms - Asana, Pranayama or Dhyana and relaxation practices were mentioned but not no details provided) PR: Pulse rate, BP: Blood pressure, LC: Lymphocyte count, UA: Serum uric acid, AIIMS: All India Institute of Medical Sciences, ACYTER: The Advanced Centre for Yoga Therapy Education and Research, JIPMER: Jawaharlal Institute of Postgraduate Medical Education and Research

3.10.3 Methodological quality of included studies

Overall, the methodology was not adequately reported in the included studies, which resulted in low methodological quality scores (total "yes" response percentage on the checklist ranging from 25% to 66%) (Table 16). Some major issues included inadequate reporting of allocation concealment, imbalances between the characteristics of treatment groups at baseline, inadequate description of blinding of participants and outcome assessors, inadequate reporting of whether the study arms were treated identically other than the intervention of interest, no or insufficient analysis of the differences between study groups about the loss to follow-up and reasons for incomplete follow up, inadequate reporting of ITT analysis and its details, no or inadequate description of the number of outcome assessors or their training, missing information on statistical power analysis calculations and assumptions of statistical tests used, and errors in statistical analysis and reporting.

Table 16 Methodological assessment of the included studies.

Author and year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Total % of "Y" (excluding "N/A")
Singh, 2011	U	U	Y	U	N/A	U	U	Y	N	N	U	U	Y	25
Ward, 2018	Y	Y	N	U	N/A	Y	Y	Y	U	Y	U	U	Y	58
Gautam, 2019, 2020, 2021, 2022, 2023	Y	Y	N	N	N/A	Y	Y	Y	U	Y	U	Y	Y	66
Ganesan, 2020	Y	U	Y	U	N/A	U	U	U	U	Y	U	Y	Y	42
Pukšić, 2021	Y	U	Y	U	N/A	Y	Y	U	U	Y	U	Y	Y	58

This tool uses a series of criteria that can be scored as being met (yes), not met (no), unclear or not applicable (N/A). Y=yes; N=no; U=unclear; NA=not applicable. In real practice, it is practically impossible to blind the yoga provider. So, the response to question 5 of the checklist was marked as N/A (not applicable) in our methodological assessment.

JBI critical appraisal checklist for randomised controlled trials: Q1. Was true randomisation used for assignment of participants to treatment groups? Q2. Was allocation to treatment groups concealed? Q3. Were treatment groups similar at baseline? Q4. Were participants blind to treatment assignment? Q5. Were those delivering treatment blind to treatment assignment? Q6. Were treatment groups treated identically other than the intervention of interest? Q7. Were outcomes assessors blind to treatment assignment? Q8. Were outcomes measured in the same way for treatment groups? Q9. Were outcomes measured in a reliable way? Q10. Was follow-up complete and if not, were differences between groups in terms of their follow up adequately described and analysed? Q11. Were participants analysed in the groups to which they were randomised? Q12. Was appropriate statistical analysis used? Q13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomisation, parallel groups) accounted for in the conduct and analysis of the trial?

3.10.4 Meta-analysis to determine studies with effective yoga interventions

The extracted outcome data from all studies and their details are provided in Table 17. All five studies (nine articles) were included in the meta-analysis to identify the individual effective interventions for each outcome: disease activity score (four studies), pain (three studies), and function (three studies). These studies compared yoga interventions in addition to conventional medicine with the following comparators: (i) conventional medicine, including prescribed DMARDs, along with a normal daily routine and not enrolling in any exercise regime/aerobic activities/yoga for the intervention duration[259,260-264], (ii) wait-listed control[258,265], and (iii) education on arthritis-related topics and discussion facilitated by a rheumatologist[266]. All comparators in our included studies involved standard medications[258,259,260-264,265,266], specifically DMARDs[259,260-264,266], except one comparator included an additional education component[266]. Yoga interventions with conventional medicine reduced disease activity scores (four RCTs; SMD -0.46; 95% CI -0.73 to -0.18) (Figure 14) and improved function (three RCTs; -0.42; -0.78 to -0.07) (Figure 15) but were not effective in reducing pain (three RCTs; -1.06; -2.62 to 0.50) (Figure 16) as compared to comparators. Effective results for disease activity score, pain, and function were reported in three

individual RCTs[263,265,266], two individual RCTs[258,266], and two individual RCTs[259,266], respectively. In other words, yoga interventions in all five included RCTs were effective on disease activity score, pain, and/or function.[258,259,260-264,265,266] Meta-regression analysis could not be conducted as fewer than 10 studies could be included in the meta-analysis.[211]

Table 17 Extracted outcome data.

Author and year	Pain (Post-intervention) Mean ± SD	Function (Post-intervention) Mean ± SD	Disease activity (Post-intervention) Mean ± SD	Adverse events related to intervention (including serious adverse events)	Measureme nt time point at the end/closest to the end of intervention for disease activity score and/or pain and/or function
Singh 2011	**SDPIS (0-5) I=0.20±0.52 C=1.92± 0.76**	-	-	NR	40 days/ 7 weeks
Ward 2018	**VAS (0-100 mm) I=33±21.00 C=33±32.00**	**HAQ-DI (0-3) I=0.35±0.35 C= 0.83±0.76**	**CDAI I=11.5±7.30 C=9.6±7.60**	Nausea: I=6 (6 events reported by 1 participant) -No serious AEs	9 weeks
Gautam 2019	-	**HAQ-DI I=0.44±0.36 C=0.50±0.38**	DAS28-ESR I=4.42±0.93 C=4.8±0.87	NR	8 weeks
Gautam 2020	-	-	DAS28-ESR I=4.5±0.90 C=4.9±0.80	NR	8 weeks
Gautam 2021	-	HAQ-DI I=0.45±0.30 C=0.52±0.40	DAS28-ESR I=4.5±0.90 C=4.8±0.85	NR	8 weeks
Gautam 2022	-	-	**DAS28-ESR I=4.1±0.90 C=4.5±1.30**	NR	8 weeks
Gautam 2023	-	-	DAS28-ESR I=3.8±0.90 C=4.3±1.30	NR	8 weeks
Ganesa n 2020	-	-	**DAS28 I=2.99±0.78 C=3.49±0.78**	NR	12 weeks
Pukšić 2021	**VAS (0-10 cm) I=2.42±1.79 C=3.63± 2.57** SF-36 (0-100) Bodily pain I=69.48± 19.48 C=54.48± 19.04	**SF-36 (0-100) I=70.83± 19.82 C=59.36± 20.50**	**DAS28CRP (used inter-changeably with DAS28ESR) I=2.24±0.59 C=2.82±0.99**	I=1(Persistent positional vertigo (supine position) C=none -Serious AEs-none	12 weeks

SDPIS: Simple Descriptive Pain Intensity Scale, CRP: C-reactive protein, VAS: Visual Analogue Scale, HAQ-DI: Health Assessment Questionnaire Disability Index, CDAI: Clinical Disease Activity Index, DAS-Disease activity score, ESR: Erythrocyte sedimentation rate, IL: Interleukin, TNF- Tumour necrosis factor, HLA-G: Human leukocyte antigen G, SF-36: Short Form 36, NR: Not reported
Data used for meta-analysis have been represented in **bold** stye.

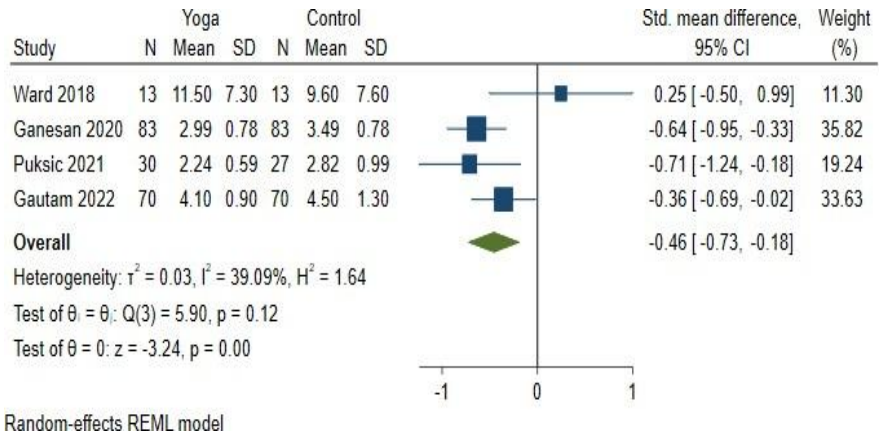


Figure 14 Forest plot for the outcome disease activity score, comparing yoga in addition to conventional medicine versus the comparator group.

Disease activity scores were reported in the studies by Gautam et al, but the values reported in the 2022 study by Gautam et al (the largest sample size) were extracted because it had the largest sample size.

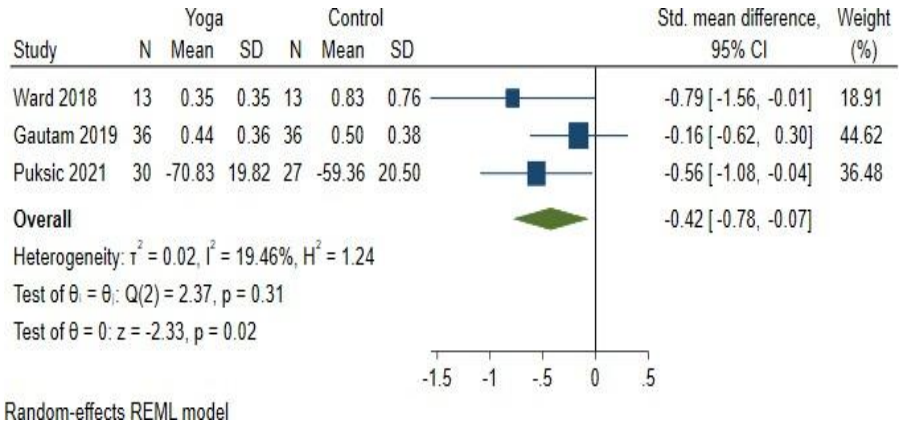


Figure 15 Forest plot for the outcome function, comparing yoga in addition to conventional medicine versus the comparator group.

Function scores were reported in the 2019 and 2021 studies by Gautam et al,[260,262] but the values reported in the 2019 study by Gautam et al were extracted because it had the largest sample size. CI, confidence interval; N, sample size; REML, restricted maximum likelihood

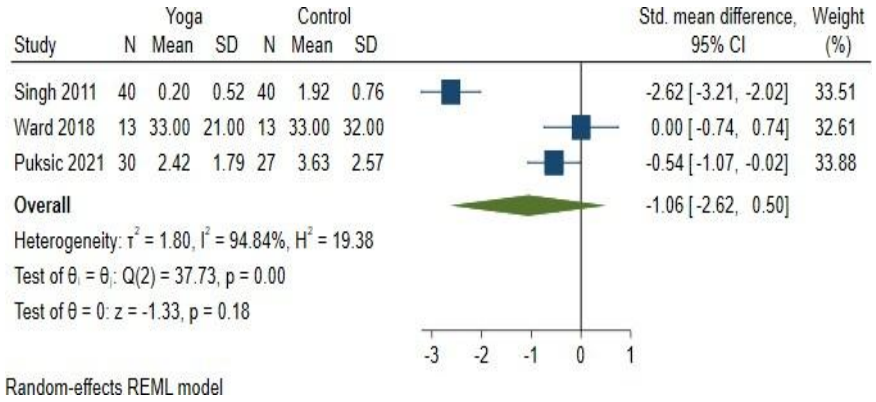


Figure 16 Forest plot for the outcome pain, comparing yoga in addition to conventional medicine versus the comparator group.

CI, confidence interval; N, sample size; REML, restricted maximum likelihood.

3.10.5 Certainty of the evidence

Using the GRADE approach (Summary of Findings Table – Table 18), moderate-certainty evidence was found for disease activity score and function, while very low-certainty evidence was found for pain. There was no indirectness of evidence; however, publication bias could not be assessed due to fewer than 10 studies.

Table 18 Summary of findings
Yoga in addition to conventional medicine for RA

Patient or population: People with RA
Setting: Primary, secondary, tertiary or community
Intervention: Yoga (in addition to standard medical treatment for RA)
Comparison: Non-yoga comparator (i.e., wait-listed control or health education on RA)

Outcomes	**Anticipated absolute effects*** (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with comparator	Risk with yoga (in addition to standard medical treatment)				
Pain	-	SMD 1.06 lower (2.6 lower to 0.48 higher)	-	163 (3 RCTs)	⊕◯◯◯ Very low[a, b,]	
Function	-	SMD 0.42 lower (0.76 lower to 0.07 lower)	-	155 (3 RCTs)	⊕⊕⊕◯ Moderate[b]	
Disease activity	-	SMD 0.45 lower (0.75 lower to 0.15 lower)	-	389 (4 RCTs)	⊕⊕⊕◯ Moderate[b]	

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI). **CI:** confidence interval; **SMD:** standardised mean difference . **High certainty:** we are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect. **Very low certainty:** we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect. Explanations a. Statistical heterogeneity, b. Small sample size

3.10.6 Content, structure, and delivery characteristics of effective yoga interventions for disease activity score, pain, and/or function

The yoga interventions of all five RCTs included centre-based (supervised, group) sessions[258,259,260-264,265,266], and two interventions had additional home-based (unsupervised, individual) sessions[259,265]. The median duration was eight weeks (IQR 8-12 weeks) and each session was around 68 minutes (nearly 1 hour 10 minutes) (IQR 60-85 minutes), and these sessions were delivered in varied frequencies, ranging from once a week[259] to daily[258]. Home-based yoga practice was recommended thrice weekly for a mean duration of 10 weeks and 40 minutes per session.[259,265] All five RCTs reported the major components of yoga used.[258,259,260-264,265,266] The content of yoga interventions was heterogeneous and included 20 different yogic poses (asana; six standing, five supine, five prone, and four seated), seven breathing practices (pranayama), and four meditation (dhyana) and relaxation practices. All included pranayama and dhyana and relaxation practices[258,259,260-264,265,266] and four also included asana[258,259,260-264,265]. None of these interventions mentioned the yoga style used. Interventions that included all three major components of yoga reported the time allocated to each component.[258,259,260-264,265] The median time allocated to asana was around 29 minutes (IQR 17-39 minutes)[258,259,260-264,265],

pranayama was around 20 minutes (IQR 7-20 minutes)[258,259,260-264,265,266] and dhyana and relaxation practices were around 25 minutes (IQR 15-25 minutes)[258,259,260-264,265,266]. Some of the common practices were Pawanmuktasana (wind-relieving pose)[258,259,260-264,265], Bhujangasana (cobra pose)[258,260-264,265], Nadishodhana pranayama (alternate nostril breathing)[258,260-264,265,266], Bhramari pranayama (humming bee breathing)[258,260-264,265], Nadanusandhana (A-U-M Kara chanting)[258,260-264,265,266], and Savasana (corpse pose)[258,260-264,265]. Table 12 describes the various yoga practices effective for disease activity score, pain, and/or function.[230,231]

Where reported (one of five interventions), centre-based yoga sessions were delivered in a progressive manner, i.e., new postures were introduced every two weeks, which were upgraded from predominantly supine to standing posture.[259] To accommodate participants' functional limitations, supine postures were practised on an electronic treatment table, which assisted the participants with self-mobilisation up and down from the floor, and alternative seated versions were taught for standing postures for those uncomfortable with weight-bearing on their feet.[259] Additionally, yoga postures were adapted (two of five interventions) using props such as exercise balls, blocks, belts, armless chairs, pillows, and

blankets, to accommodate participants' needs (e.g., to maintain correct postural alignment and avoid excess kneeling).[259,266] The use of CDs was reported to facilitate guided relaxation practices during home-based yoga practice (one of two interventions).[259] Where reported (one of five interventions), strategies were used to monitor and improve adherence to yoga practice at the centre, e.g., by keeping track of yoga practice (self-recorded by participants in yoga diaries shared with the yoga providers) and yoga providers' remarks at each visit.[260-264] Further, strategies were also used to monitor and increase adherence to yoga practice at home, e.g., by reminding and motivating the participants through phone calls[265], verbally sharing details of home practice with the yoga provider at the beginning of each session[259] and discussion of barriers and facilitators to home practice amongst the yoga participants[259]. Participants were encouraged to incorporate yoga practice into their daily lives for the long term (two of five interventions).[260-264,266]

Table 19 Yoga practices used in effective interventions for disease activity score, pain, and/or function.

Asana				**Pranayama**			**Dhyana and relaxation practice**		
Sanskrit Name	**English Name**	**Type of yoga (standing, sitting, supine or prone)**	**Effective studies reporting use of the asana for disease activity score and/or pain and/or function**	**Sanskrit Name**	**English name**	**Effective studies reporting use of the pranayama for disease activity score and/or pain and/or function**	**Sanskrit name**	**English Name**	**Effective studies reporting use of the dhyana and relaxation practice for disease activity score and/or pain and/or function**
Pawanmuktasana	Wind relieving pose	Supine pose	Disease activity score[260-264,265] Pain[258] Function[259]	Nadishodhana pranayama	Alternate nostril breathing	Disease activity score[260-264,265,266] Pain[258] Function[266]	Nadanusandhana	OM meditation/ A,U,M and A-U-M Kara chanting	Disease activity score[260-264,265,266] Pain[258] Function[266]
Marjari asana	Cat pose	Prone pose	Pain[258]	Chandrabhedi pranayama	Left nostril breathing	Disease activity score[265]	Savasana	Corpse pose, palms up	Disease activity score[260-264,265] Pain[258]
Vakranasana	Twisted pose	Seated pose	Disease activity score[260-264] Pain[258]	Bhramari Pranayama	Humming bee breathing	Disease activity score[260-264,265] Pain[258]	Anantasana	Sleeping Vishnu pose/side-reclining leg lift	Disease activity score[266] Function[266]

Shashankasana	Rabbit pose or hare pose	Seated pose	Disease activity score[260-264] Pain[258]	Dirga/Mahat pranayama	Complete yogic breath (utilising abdominal, thoracic and clavicular part of the breath)	Disease activity score[266] Function[266]	NR	Short relaxation	Disease activity score[266] Function[266]
Bhujangasana	Cobra pose	Prone pose	Disease activity score[260-264,265] Pain[258]	Kapalbhati Pranayama	Skull shining breathing	Disease activity score[260-264]	NR	Self-inquiry meditation	Disease activity score[266] Function[266]
Poorna shalabhasana	Locust pose	Prone pose	Disease activity score[260-264]	Ujjayi Pranayama	Victorious breath	Disease activity score[260-264]	Soham mantra	Soham meditation	Pain[258]
Halasana	Plough pose	Supine pose	Pain[258]	Bhastrika Pranayama	Bellows breathing	Pain[258]	NR	Instant relaxation with Gayatri mantra	Pain[258]
Konasana	Angle pose	Standing pose	Disease activity score[265]	NR	Centring and breathing practice	Function[259]	NR	Guided relaxation	Function[259]
Urdhwa hastottanasana	Upstretched arms posture	Standing pose	Disease activity score[265]						

Trikonasana	Triangle pose	Standing pose	Disease activity score[260-264]						
Katichakrasana	Lateral arc pose	Standing pose	Disease activity score[260-264,265]						
Tadasana	Mountain pose	Standing pose	Disease activity score[260-264,265]						
Virabhadrasana	Warrior pose	Standing pose	Disease activity score[260-264]						
Gomukhasana	Cow face Pose	Seated pose	Disease activity score[260-264]						
Paschimottanasana	Seated forward bend pose	Seated pose	Disease activity score[260-264]						
Ek-pada-shalabhasana	Locust pose	Prone pose	Disease activity score[260-264]						
Makarasana	Crocodile Pose	Prone pose	Disease activity score[260-264]						
Uttanapadasana	Intense stretch of legs pose	Supine pose	Disease activity score[260-264]						

Setu bandhasana	Bridge pose	Supine pose	Disease activity score[260-264]						
Matsyasana	Fish pose	Supine pose	Disease activity score[260-264]						

NR: Not reported Standing pose: yoga poses practiced with one or both feet on the ground, and the body more or less upright, Sitting pose: Yoga poses practiced in seated position, Supine pose: Yoga poses practiced in sleeping position, Prone pose: Yoga poses performed with the belly or torso touching or facing the floor.

3.11 Discussion

3.11.1 Summary of main findings

Our systematic review identified that yoga, when delivered in addition to standard medical treatment for rheumatoid arthritis, might have beneficial effects on disease activity score, pain, and function, as also reported in previous systematic reviews.[181] However, the findings should be interpreted with caution because the certainty of the evidence assessed using the GRADE approach ranged from moderate to very low. While reductions in disease activity and function scores were statistically significant, the clinical effectiveness, in terms of effect sizes, compared to published minimal clinically important differences (MCIDs), appears to be small to moderate.[267] However, any improvement in disease activity and function scores can still be beneficial, especially when yoga is practised in addition to standard medical treatment, and this review synthesised the key features of effective interventions, which are important for developing a high- quality yoga intervention to improve rheumatoid arthritis outcomes. Supervised yoga practice in groups at a centre was one of the most consistent characteristics of the yoga interventions. This might reflect the importance of creating a "community" for yoga practice and a space for personal interactions between the patients and the yoga provider during supervised yoga sessions. This could help

them deal with negative emotions (e.g., shame) and overcome social isolation, which are major concerns in rheumatoid arthritis.[268] Participants' adherence to yoga interventions is likely to play an important role in yoga's effectiveness on rheumatoid arthritis outcomes.[269] Supervised programs are likely to have increased adherence to yoga sessions.[269,270] Another important finding of this review was that all the effective yoga interventions incorporated two major components – breathing practices and meditation and relaxation practices. It is possible that including both these components may work by stimulating the parasympathetic nervous system and relieving rheumatoid arthritis outcomes by reducing anxiety and stress.[271-273]

3.11.2 Strengths and limitations of the systematic review

To the best of our knowledge, this is the first systematic review utilising a comprehensive search using a broad range of databases and a robust methodology to synthesise the key features of effective yoga interventions for treating rheumatoid arthritis and to assess the certainty of evidence using the GRADE approach.[187,188,211] Only RCTs were included in the review, based on the hierarchy of study designs. Determination of the effectiveness of interventions was standardised across RCTs using meta-analysis before finally synthesising the detailed characteristics of effective

yoga interventions. The systematic review and meta-analysis had some limitations. Despite conducting a comprehensive search, only nine articles could be included. Although DAS28CRP values are lower than DAS28ESR values[274], possibly underestimating disease activity, and since there was a paucity of data for the conversion of DAS28CRP to DAS28ESR value in one included RCT, these were used interchangeably. This could be a limitation of our meta-analysis. Further, publication bias could not be assessed given the limited number of included RCTs. Overall, the methodology was not adequately reported, resulting in their poor methodological quality scores. Methodological quality assessment is a subjective process, and as the systematic reviewers were strict in responding to the questions in the JBI checklist, it could have led to low-quality scores. Given the statistical heterogeneity and small sample sizes, the quality of evidence for disease activity score and function was downgraded to moderate, and pain was downgraded to very low, using the GRADE approach - a key strength of this review.

3.11.3 Limitations of the included studies and future research directions

The included RCTs had limitations as well. Most included RCTs were conducted in India, which might be indicative of

the origins of yoga from the Indian subcontinent. However, this concentration raises concerns about the generalisability of the findings. Cultural familiarity with yoga in India may influence participant engagement and adherence, potentially leading to more positive outcomes than would be observed in populations less familiar with yoga. Furthermore, most studies provided limited information on participants' demographic and socioeconomic characteristics (e.g., age, education, income, urban/rural residence, and healthcare access), which prevents understanding of how these factors may affect the feasibility and effectiveness of yoga interventions, and limits insight into which populations can realistically engage with and benefit from the intervention. Evidence shows that yoga RCTs conducted in India have increased odds of reaching positive conclusions than those conducted elsewhere.[275] This might limit the generalisability of our findings as they may not accurately represent the broader global population of rheumatoid arthritis patients, warranting future trials to be conducted in various countries for a wider geographical representation. Additionally, many of the included RCTs had relatively small sample sizes, which reduces statistical power and limits the ability to detect meaningful differences or variations in response across participant subgroups.

Participants in the included RCTs were predominantly females. Although rheumatoid arthritis is more common in females, it also affects males. The limited inclusion of males represents a gap, as male-specific barriers to yoga practice (e.g., gender-based perceptions) were largely unaddressed. So, future trials must recruit more male participants with rheumatoid arthritis and undertake initiatives to overcome the potential barriers to yoga practice among males (e.g., men-only yoga classes to overcome gender-based perceptions of yoga), ensuring their concerns are addressed.[235,276]

Most RCTs did not specify yoga providers' credentials; instead, they only described them as 'qualified' or 'experienced'. There was also no description of whether they were bespoke trained to deliver the specific intervention to the rheumatoid arthritis patients. Yoga providers with a minimum level of training and expertise, and specific training in the intervention protocol, are crucial to the effectiveness of the intervention and in ensuring its fidelity and safety.[186,233,234] Future RCTs should therefore ensure adequate reporting of these details.

Yoga-related adverse events were not reported in most RCTs, limiting understanding of the intervention's safety and this should be improved in future trials to indicate the safety of

yoga. Only two RCTs reported encouragement of long-term yoga practice. Since rheumatoid arthritis is a chronic condition, it will be important to explore the long-term impact of yoga through follow-up assessments at different periods.

Future research should aim to develop a yoga intervention for rheumatoid arthritis using our synthesised findings and conduct a high-quality RCT with a large enough sample size. The development work requires the involvement and engagement of rheumatoid arthritis patients, rheumatologists, yoga experts and providers, rheumatology nurse specialists, occupational therapists, and physiotherapists. Inputs from them will help identify the effective components of the intervention using Delphi or other consensus techniques.[277] Future studies should also account for disease duration, as individuals with early versus long-standing rheumatoid arthritis may respond differently to yoga interventions. If found to be effective and safe, its implementation and integration into healthcare systems will be important.[240]

3.12 Conclusion

Despite methodological limitations and heterogeneity among the included studies, yoga might be useful in addition to conventional medicine for people with rheumatoid arthritis. Effective interventions commonly incorporated asanas (yogic

poses), pranayama (breathing practices), and dhyana (meditation) and relaxation practices, delivered through both supervised centre-based and unsupervised home-based sessions. However, most studies were conducted in India, predominantly included female participants, provided limited reporting on yoga provider credentials, participant demographics, and safety, and rarely examined long-term effects, which restricts the generalisability of the findings. These findings provide preliminary support for yoga as a complementary approach to rheumatoid arthritis treatment. A high-quality RCT based on our synthesised key features of effective yoga interventions should be conducted to establish its effectiveness, safety, and long-term impact, while adjusting for disease duration to better understand its effects on outcomes. Future studies should recruit more diverse populations, ensure transparent reporting of yoga intervention components and yoga provider training, and assess the sustainability of yoga practice.

Chapter Four: Barriers and facilitators to yoga practice among people living with arthritis: a qualitative systematic review

4.1 Introduction

The preceding chapters of this thesis (Chapters Two and Three) synthesised global quantitative evidence on the effectiveness and defining features of effective yoga interventions for osteoarthritis and rheumatoid arthritis. Those findings demonstrated promising benefits of yoga as a complementary approach, highlighting common structural and delivery characteristics associated with improved pain and function. However, translating these insights into real-world settings requires a deeper understanding of how people with arthritis experience yoga, the factors that encourage or hinder participation, and the contextual influences that shape engagement. Quantitative data alone cannot capture these nuanced, person-centred perspectives.

Systematic reviews and meta-analyses suggest that yoga is safe and can be beneficial in the treatment of arthritis, particularly the most prevalent types, i.e., osteoarthritis and rheumatoid arthritis, as supported by the findings presented in Chapters Two and Three of this thesis (also published as peer-reviewed manuscripts).[176,181,278,279] Further, the ACR and the EULAR guidelines conditionally recommend yoga as a complementary approach for the treatment of knee osteoarthritis and rheumatoid arthritis.[113,114] Qualitative research can provide insights into why people with arthritis

may or may not practice yoga. Such studies have explored the factors that impede (barriers) and encourage (facilitators) yoga practice among people with arthritis.[182,183,280] However, no systematic review on this topic has been conducted to date. Therefore, this chapter aims to conduct a systematic review of qualitative evidence to synthesise the barriers and facilitators to yoga practice in people with arthritis. It is hoped that the review findings could be used to address the barriers through appropriate actions and promote the facilitators of yoga practice among people living with arthritis.

Review question: What are the barriers and facilitators to yoga practice among people living with arthritis?

4.2 Methods

The review followed JBI methodological guidance on systematic reviews of qualitative evidence.[281] It was reported according to the Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ) statement and the PRISMA guidelines.[188,282] This review protocol was registered with PROSPERO (CRD42023483350).

4.3 Inclusion criteria

Participant: This review included studies conducted among adults (aged ≥18 years) diagnosed with arthritis of any type. No restrictions on diagnostic criteria were applied.

Phenomena of interest: This review included studies that explored the knowledge, experiences, attitudes, understandings, perceptions, or perspectives that may act as barriers and facilitators to yoga practice.

Context: This review considered studies undertaken in any global context and setting (e.g., community, primary care, secondary care, or tertiary care).

Study design: This review considered studies that had qualitative data, including, but not limited to, designs such as phenomenology, ethnography, action research, case studies, grounded theory, and feminist research. Other study designs, such as mixed methods, quasi-experimental, and cross-sectional descriptive studies, reporting relevant qualitative data, were also included.

4.4 Data sources and search strategy

Six electronic databases were searched from their inception dates until 07 November 2024 to locate published studies: (i) MEDLINE (Ovid; from 1946), (ii) Embase (Ovid; from

1974), (iii) CINAHL Plus (EBSCOhost; from 1937), (iv) PsycInfo (Ovid; from 1806), (v) AMED (Ovid; from 1985), and (vi) Web of Science (from 1900). In addition, ProQuest Dissertations and Theses were searched for unpublished studies. The search strategies were developed for all the databases in consultation with an experienced research librarian at the University of Nottingham, UK. The search strategy was initially developed for MEDLINE and then adapted as necessary across other databases. "Yoga" and "arthritis" search concepts were based on the search strategies used in previous relevant systematic reviews.[278,279] Predesigned database-specific search filters were used for the "qualitative study design" concept, where possible.[283] No language restrictions were applied. The search strategies are detailed in Appendix 5. The reference lists of all the included studies were screened for additional studies.

4.5 Study screening and selection

Following the searches, all identified citations were collated and uploaded into EndNote X9[200] and de-duplicated. The remaining records were then imported into Rayyan[201] to facilitate the title and abstract screening process, undertaken by two independent reviewers. Studies identified as potentially eligible or those without an abstract were retrieved in full text, and their details were imported into the JBI

System for the Unified Management, Assessment and Review of Information (JBI SUMARI).[284] The full text of the studies was then assessed in detail against the inclusion criteria by the two independent reviewers. Any disagreements between the two reviewers at each stage of the study selection process were resolved through discussion or by involving a senior reviewer if a consensus was not reached.

4.6 Assessment of methodological quality

The two independent reviewers assessed all eligible studies using the standardised critical appraisal checklist for qualitative research incorporated within JBI SUMARI.[284] The checklist uses a series of criteria that can be scored as being met (yes), not met (no), unclear, or, where appropriate, not applicable (N/A) to the particular study. They went through each criterion and commented on it. Any disagreements between reviewers were resolved through discussion or by involving a senior reviewer. All studies, regardless of their methodological quality, underwent data extraction and synthesis where possible.

4.7 Data extraction

The two independent reviewers extracted data using the standardised data extraction tool incorporated within JBI SUMARI.[284] Any disagreements were resolved through

discussion or by involving the third reviewer. The following details were extracted: author and year of publication, country, phenomena of interest, yoga delivery setting, participant recruitment setting, qualitative research methodology, study design, sample size and participant characteristics (type of arthritis, age, sex, and disease duration), data collection methods, and data analysis technique. Next, findings (i.e., extracted themes from included studies), with relevant illustrations (i.e., quotes or supportive data cited in the included studies for each finding), were extracted. The findings and illustrations were the actual verbatim words of the study authors and participants, respectively. Each finding was then assigned a level of credibility: unequivocal (U) (i.e., evidence beyond a reasonable doubt), credible (C) (i.e., evidence that was open to challenge), or not supported (NS) (i.e., findings were not supported by the data).[284]

4.8 Data synthesis

All authors were involved in data synthesis. The extracted study details were first narratively synthesised. Then, study findings were pooled using JBI SUMARI, following a meta-aggregation approach.[284,285] Meta-aggregation produces a generalisable statement to inform policymaking, and it examines the essence of the qualitative data by maintaining

the original meaning and avoiding reviewers' influence on the text.[285] Alternative approaches to qualitative synthesis include thematic synthesis (generating new analytical themes)[286], meta-ethnography (producing conceptual or theoretical models)[287], and framework synthesis (mapping findings onto predetermined frameworks)[288], which generally involve a higher level of interpretation and theory generation. In contrast, meta-aggregation provides a more pragmatic and practice-oriented approach as it aims to produce synthesised findings that are directly applicable to real-world contexts, while maintaining fidelity to the original data. This makes meta-aggregation well aligned to the aims of the current systematic review, which seeks to generate actionable, practice-relevant insights while minimising reviewer bias.[285]

The findings were synthesised based on similarity in meaning to generate a set of statements called categories. These categories were then subjected to a synthesis to produce a single comprehensive set of synthesised findings. The initial plan was to synthesise data separately for each type of arthritis to identify any differences or similarities in the knowledge, experiences, attitudes, understandings, perceptions, or perspectives that may act as barriers or facilitators to yoga practice.

Initially, the lead reviewer grouped findings assigned as either unequivocal or credible into categories based on similarity in meaning and concept through discussions with the second reviewer. Each finding was labelled, and the related or similar ones were grouped under a representative name. This iterative process continued until all reviewers reached consensus to ensure that the findings were placed under appropriate categories.

To interpret the categories as barriers or facilitators, patterns in the data and their relevance to the review objective were analysed. This process helped identify factors influencing yoga practice in people with arthritis, providing a clearer understanding of both barriers and facilitators. The lead reviewer refined the categories and aggregated them into synthesised findings through repeated discussions with other reviewers, formulating statements to represent each.

4.9 Results

4.9.1 Study inclusion

The study selection process is detailed in the PRISMA flowchart, as shown in Figure 17. 1330 records were identified through the literature search. After removing duplicate records and title and abstract screening, 15 articles were retrieved for full-text screening. Nine articles,

representing eight studies, were included in the review.[182-184,280,289-293] Appendix 6 provides information on excluded studies and the reasons for exclusion. No additional articles were identified from citation searching.

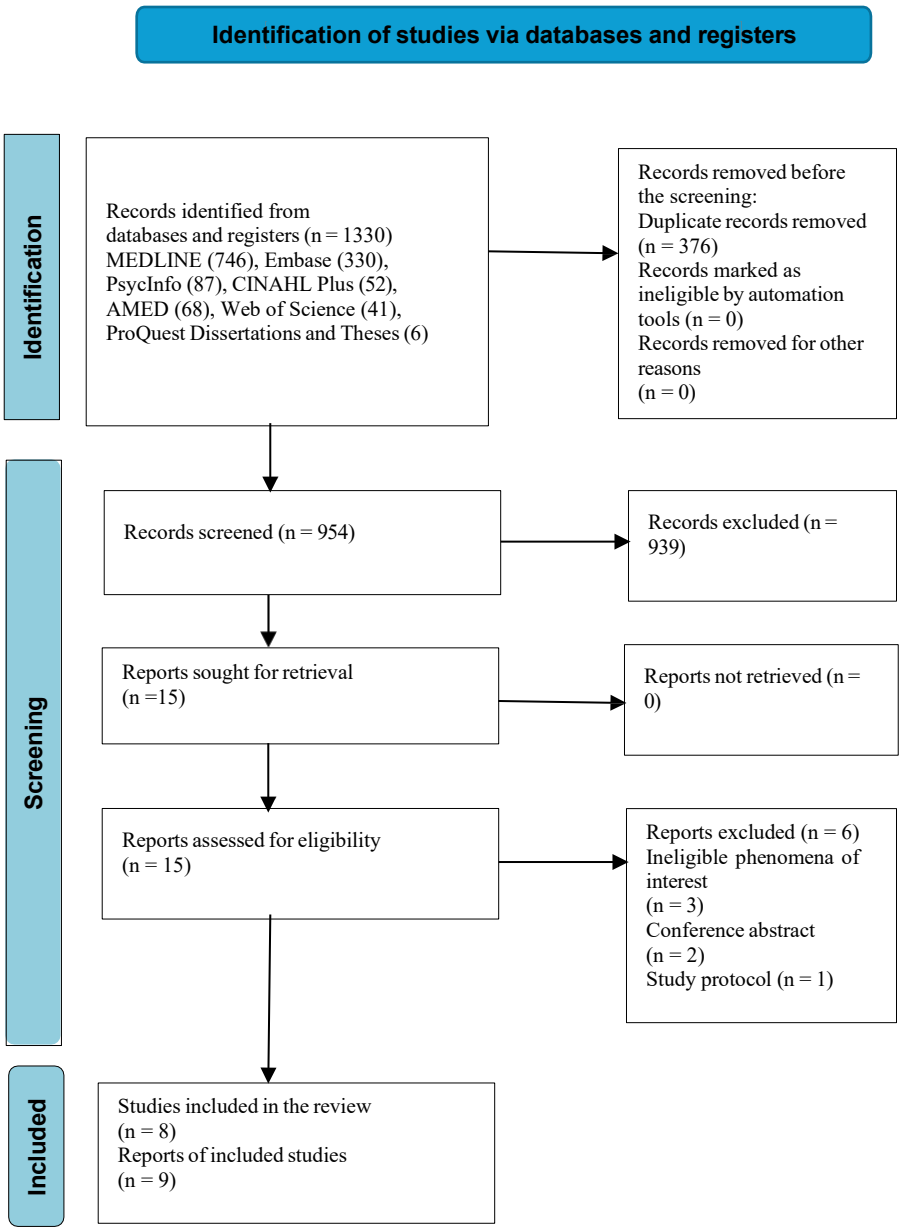


Figure 17 PRISMA flow diagram for included studies from searches of databases and registers only.

4.9.2 Characteristics of included studies

Table 20 describes the characteristics of the eight included studies (nine articles).[182-184,280,289,290-293] Two articles originated from the same study.[183,289] Each had different aims and data analysis techniques, but were based on the same set of qualitative interview data; hence, they were considered a single study in this review.[183,289] The included studies were published over 12 years from 2010 to 2022.[182,183,280,289,290-293] All studies were conducted in high-income countries, specifically, New Zealand[293], the UK[184], and the USA[182,183,280,289-292]. All studies explored views, experiences, perceptions, or perspectives of people with arthritis regarding yoga practice, undertaken in group yoga sessions[182,183,289,280,290,291-293] or as one-on-one yoga therapy sessions[184]. Participants were recruited solely from community settings in three studies[280,290,292], presumed secondary care settings in three studies[184,291,293], and tertiary care settings in one study[182]. Additionally, in one study, participants were recruited from both presumed secondary care and community settings.[183,289] In six studies, yoga interventions were delivered as group sessions in community settings[182,183,280,289-292], including two studies where participants also practised individually at home[280,290]. In one study, the yoga intervention was delivered in one-on-one sessions, presumably in a secondary care setting and also

practised individually at home.[184] Another study explored insights regarding a potential yoga intervention but did not include its actual delivery.[293] Regarding qualitative research methodology, seven studies employed descriptive methodologies[182,184,280,290-293]. One study used both ethnographic[289] and phenomenological[183] methodologies (reported in two separate articles). Four studies solely used a qualitative study design[182,280,291,293], two used mixed methods study designs[183,184,289], one used quasi- experimental[292], and one used a cross-sectional descriptive study design[290], allowing extraction of relevant qualitative data. The number of study participants ranged from 5[183,289] to 31 participants[290]. Where reported, the mean age of the participants ranged from 28 years[183,289] to 72 years[290]. Five studies included both male and female participants[183,289,184,291-293], and three included only females[182,280,290]. The mean disease duration ranged from eight years[184] to 21 years[291]. Data collection methods primarily included interviews[182-184,280,289,290,291], one of which used telephone interviews[291]. The remaining studies used focus group discussions for collecting data[292,293]. Data analysis techniques included thematic analysis[184,291-293], content analysis[280,182,290], and phenomenological[183] and ethnographic content analysis[289] (the latter two were applied in one study, reported as two distinct articles).

Table 20 Characteristics of included studies.

Author and year of publication	Country	Phenomena of interest	Participant recruitment setting	Yoga delivery setting	Qualitative research methodology	Study design	Sample size and participant characteristics (type of arthritis, age in years [mean (SD or range)], sex, disease duration in years [mean (SD or range)])	Data collection methods	Data analysis technique
Evans, 2010	USA	Exploring the range and depth of experiences regarding an IY programme	Secondary care? and community	Group sessions in community	Ethnography	Mixed methods	5 participants with RA Age: 28 (3) 4 females and 1 male Disease duration: 16 (8.5)	Face-to-face semi-structured interviews	Ethnographic content analysis
Evans, 2011	USA	Exploring potential mechanisms of change as a result of participating in an IY programme	Secondary care? and community	Group sessions in community	Phenomenology	Mixed methods	5 participants with RA Age: 28 (24-31) 4 females and 1 male Disease duration: 16 (8-28)	Face-to-face semi-structured interviews	Phenomenological analysis

Park, 2011	USA	Exploring the pain reduction, well-being, mood, and functional benefits after participation in a chair yoga programme	Community	Group sessions in community	Qualitative descriptive approach	Quasi-experimental (included qualitative approach)	7 participants with OA Age: NR Females and males: NR Disease duration: NR	Face-to-face focus group discussions	Thematic analysis
Ward, 2011	New Zealand	Exploring views regarding the suitability of yoga as a non-pharmacological option in the management of RA	Secondary care?	N/A	Qualitative descriptive approach	Qualitative	22 participants with RA Age range: 26-73 19 females and 3 males Disease duration: 16	Face-to-face focus group discussions	Thematic analysis
Cheung, 2015	USA	Identifying the barriers and motivations to yoga practice and exploring the experiences of home-based yoga practice	Community	Group sessions in community and individual practice at home	Qualitative descriptive approach	Cross-sectional descriptive (included qualitative approach)	31 participants with knee OA Age: 72 (6) All females Disease duration: NR	Face-to- face interviews and videotapes of home practice	Content analysis

Greysen, 2017	USA	Exploring community yoga practice characteristics and perceptions of how and why yoga is practised and factors influencing yoga participation as a symptom management strategy in RA	Secondary care?	Group sessions in community	Qualitative descriptive approach	Qualitative	17 participants with RA Age: 56 (11) 16 females and 1 male Disease duration: 21 (11)	Telephonic structured interviews	Thematic analysis
Middleton, 2017	USA	Identifying the barriers and facilitators to an adapted HY programme among adults from minority groups (English or Spanish speaking)	Tertiary care	Group sessions in community	Qualitative descriptive approach	Qualitative	12 participants with either OA or RA Age: 64 (33-65) All females Disease duration: NR	Face-to-face semi-structured interviews	Content analysis
Cartwright, 2020	UK	Exploring experiences and perspectives of an adapted YT intervention based on principles of Viniyoga	Secondary care?	One-on- one sessions in secondary care? and individual practice at home	Qualitative descriptive approach	Mixed methods	10 participants with RA Age: 54 (13) 9 females and 1 male Disease duration: 8 (6)	Face-to-face semi-structured interviews	Thematic analysis

Cheung, 2022	USA	Uncovering the experience and perspectives of long-term practice of a structured HY programme and identifying the barriers to and facilitators of adherence to the programme	Community	Group sessions in community and individual practice at home	Qualitative descriptive approach	Qualitative	28 participants with knee OA Age: 71 (8) All females Disease duration: NR	Face-to-face semi-structured interviews and focus group discussions	Inductive content analysis

?=Unclear, HY=Hatha yoga, IY=Iyengar yoga, N/A=Not applicable, NR=Not reported, OA=Osteoarthritis, RA=Rheumatoid arthritis, SD=Standard deviation, UK=United Kingdom, USA=United States of America, YT=Yoga therapy; All included studies are referenced in full in the reference list.

4.9.3 Methodological quality of included studies

The critical appraisal results of the eight included studies are presented in Table 21. Overall, the methodological quality ranged from moderate to high. None of the studies met all of the appraisal criteria. Seven studies had "yes" responses to seven or more questions on the checklist.[182,184,183,289,290-292,280] All studies met the criteria for Q2, Q3, Q4, Q5, Q8, and Q10. However, three questions consistently yielded lower ratings: inadequate reporting of congruity between the stated philosophical perspective and the research methodology (Q1); inadequate reporting of cultural or theoretical positioning of the researcher (Q6); and limited reporting of the influence of the researcher on the study and vice-versa (Q7).

Table 21 Critical appraisal of included studies.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Evans 2010, 2011	U	Y	Y	Y	Y	U	U	Y	Y	Y
Park, 2011	Y	Y	Y	Y	Y	U	U	Y	Y	Y
Ward, 2011	U	Y	Y	Y	Y	N	U	Y	U	Y
Cheung, 2015	U	Y	Y	Y	Y	U	U	Y	Y	Y
Greysen, 2017	U	Y	Y	Y	Y	U	U	Y	Y	Y
Middleton, 2017	U	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cartwright, 2020	U	Y	Y	Y	Y	N	Y	Y	Y	Y
Cheung, 2022	U	Y	Y	Y	Y	U	U	Y	Y	Y
Total % of "Y"	13	100	100	100	100	13	25	100	88	100

Y=yes; N=no; U=unclear.

JBI critical appraisal checklist for qualitative research: Q1 Is there congruity between the stated philosophical perspective and the research methodology? Q2 Is there congruity between the research methodology and the research question or objectives? Q3 Is there congruity between the research methodology and the methods used to collect data? Q4 Is there congruity between the research methodology and the representation and analysis of data? Q5 Is there congruity between the research methodology and the interpretation of results? Q6 Is there a statement locating the researcher culturally or theoretically? Q7 Is the influence of the researcher on the research, and vice-versa, addressed? Q8 Are participants, and their voices, adequately represented? Q9 Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body? Q10 Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?

4.9.4 Review findings

Table 22 depicts the meta-aggregation of findings. A total of 112 findings were extracted from nine articles, of which 111 were assessed as unequivocal and one as credible. There were no unsupported findings. These were grouped into 20 categories and further interpreted into five synthesised findings. As no notable differences were identified in the extracted data across different types of arthritis, the data were synthesised collectively. Each synthesised finding, along with its corresponding categories, findings, and illustrations, is detailed in Appendix 7.

Table 22 Meta-aggregation of findings.

Synthesised finding	Category
Yoga, arthritis, and the body: The anticipated and experienced impacts of yoga on physical well-being influenced yoga practice in people with arthritis.	Barriers 1a. Yoga practice seemed "an unknown territory" that might aggravate arthritis symptoms. 1b. Uncertainty about yoga's benefits on arthritis symptoms discouraged yoga practice. Facilitators 1c. Experiencing relief from arthritis symptoms as a result of yoga practice. 1d. Yoga seemed to elevate body awareness and physical vitality, translating into people's daily lives. 1e. Yoga practice was perceived to reduce reliance on arthritis medication for pain relief.
Yoga, arthritis, and the mind: Levels of motivation and perceived impact on mental well-being influenced yoga practice in people with arthritis.	Barriers 2a. Wavering intrinsic motivations (concentration, self-efficacy, and self- assurance) negatively influenced yoga practice. Facilitators 2b. High levels of intrinsic motivations (personal interest in yoga, prioritising health, self-efficacy, self-assurance, and self-confidence) facilitated yoga practice. 2c. Extrinsic motivations (doctor's advice, reduced price of yoga sessions, improvement in other health conditions, exposure to yoga, and peer/family support) positively influenced yoga practice in arthritis. 2d. Perception of improvements in mental well-being could encourage yoga practice.
Yoga, arthritis, and the mind-body impact: The experience of mind-body benefits of yoga fostered a positive outlook on coping with arthritis and encouraged ongoing engagement with yoga practice in people with arthritis.	Facilitators 3a. Practising yoga gave people with arthritis a sense of empowerment, i.e., the ability to take control of their condition. 3b. Yoga was appreciated as a beneficial coping strategy for arthritis. 3c. Practising yoga changed the way people with arthritis viewed their condition, allowing them to rediscover themselves and regain a sense of normalcy in their lives. 3d. Consistent yoga practice was perceived as essential for achieving long-term holistic benefits for arthritis.

Yoga, arthritis, and session accessibility and structure: Engagement with yoga practice was influenced by individually determined factors affecting access to sessions, as well as by the structural characteristics of the sessions.	<u>Barriers</u> 4a. Juggling with logistical challenges to attending yoga sessions discouraged yoga practice. 4b. Unsatisfactory yoga experiences, including the difficulty level of the practices and discomfort, hindered yoga practice. <u>Facilitators</u> 4c. Yoga's adaptability and well-paced sessions to suit people's needs and preferences in arthritis were perceived to be helpful. 4d. Availability of a yoga provider with positive qualities, knowledge, and professional training facilitated yoga practice. 4e. The provision of props and resources was perceived to offer confidence and security for yoga practice.
Yoga, arthritis, and the session environment: A supportive social environment in yoga sessions, characterised by a welcoming space and meaningful connections, encouraged yoga practice in people with arthritis.	<u>Facilitators</u> 5a. Safe and supportive space (in group sessions) and a "therapeutic" space (in one-to-one sessions) were considered important for yoga practice. 5b. Social connectedness in a group setting was perceived as a strong motivation for yoga practice.
Total synthesised findings = 5	**Total categories = 20**

1. Yoga, arthritis, and the body: The anticipated and experienced impacts of yoga on physical well-being influenced yoga practice in people with arthritis.

This synthesised finding was derived from 30 findings that were interpreted into five categories, which addressed the perceived impacts of yoga on the "body", i.e., physical well-being in arthritis. It highlighted how yoga affects physical symptoms of arthritis, thereby either hindering or facilitating yoga practice. Limited awareness of yoga's benefits led to a fear of worsening symptoms, discouraging participation. However, noticeable improvements, including relief from arthritis symptoms, increased body awareness, and energy levels, motivated yoga practice. Many reported that these physical benefits encouraged them to maintain an active lifestyle by practising yoga, and some also mentioned reduced reliance on arthritis medication.

Barriers

1a. Yoga practice seemed "an unknown territory" that might aggravate arthritis symptoms.

In this category, six findings (U) were aggregated, which showed that people with arthritis were apprehensive about practising yoga due to their limited awareness of yoga and thought that some yoga poses might be beyond their physical capabilities. Some described attempting yoga but giving up eventually as they felt it might add to their existing symptom

burden in arthritis, e.g., worsening pain, flare-ups, and even effects on comorbidities (e.g., heart problems) or cause injuries.

"I saw people at gym doing it (yoga) and you're like 'yeah right' I'm never Going to be able to do that I'm not even gonna try...at first, I didn't even consider it. You hear yoga and arthritis and you just don't think the two mix." (Evans, 2011, p4)

"I had to stop doing yoga because of my RA. I actually tried yoga again recently, but it caused a flare, so, I've got to stop doing that." (Greysen, 2017, p490)

1b. Uncertainty about yoga's benefits on arthritis symptoms discouraged yoga practice.

Two findings (U) were aggregated to create this category, which described how some people with arthritis were unsure and, at times, uncertain about yoga's benefits on their symptoms. One of them described that on some days, they would feel yoga alleviated their symptoms; on other days, they would not perceive any noticeable difference in their symptoms.

"And in terms of the pain, I think some days I thought ''Oh wow, it's really working'' and some days I don't know. It's hard to really tell." (Evans, 2010, p910)

Facilitators

1c. Experiencing relief from arthritis symptoms as a result of yoga practice.

Thirteen findings (U) were combined to form this category. People with arthritis mentioned improvement in arthritis symptoms, including pain relief, improved flexibility and mobility, stronger muscles, and reduced swelling, ultimately making them feel at ease with their bodies.

"I am very happy because I have learned yoga…it is helping me feel better, sleep better, to stretch and that helps me in my arthritis and I forget that I have it/suffer from it." (Middleton, 2017, p86)

"Some of those poses, like opening the legs up or even stretching them, helped a little bit with my range of motion and it relaxed around my joints, especially the ones that hurt the most." (Evans, 2011, p6)

1d. Yoga seemed to elevate body awareness and physical vitality, translating into people's daily lives.

This category consisted of seven findings (U). It captured accounts of people with arthritis, suggesting that yoga may have elevated their energy levels and helped cultivate physical awareness, i.e., alertness on body posture, alignment, and flexibility. One of them appreciated that practising yoga made them internally aware of how stress can sway them towards the structural misalignment of the body (e.g., bad posture) and expanded their body consciousness. They expressed that these physical health benefits translated to their daily lives, as they generally felt stronger and motivated to maintain a healthy and physically active lifestyle despite their symptoms.

"I can see how yoga can correct your body position if you keep on doing that...I'm more aware of how I can do that with my muscles too; lifting up your leg to make it straighter instead of letting your legs do whatever they want." (Evans, 2011, p6)

"It made me feel better…overall it helped, just in general helped my energy level so that helped across the board with life." (Evans, 2010, p910)

1e. Yoga practice was perceived to reduce reliance on arthritis medication for pain relief.

Two findings (U) were combined to create this category. A few individuals with arthritis shared that regularly practising yoga helped them manage their pain and allowed them to reduce their prescribed medication dosage slightly.

"Halfway through this we reduced my dose from 15 to 7.5mgs so I'm on half the dose of methotrexate and I'm doing fine on it." (Cartwright, 2020, p3)

2. Yoga, arthritis, and the mind: Levels of motivation and perceived impact on mental well-being influenced yoga practice in people with arthritis.

This finding was synthesised from four categories comprising 29 findings. It described the interconnection between mental well-being and intrinsic and extrinsic motivations, which work together to influence yoga practice in people with arthritis. Low levels of intrinsic motivation, such as low self-efficacy, self-assurance, and concentration, discouraged yoga practice in arthritis. High levels of intrinsic motivation, including personal interest, prioritising health, and a sense of accomplishment, encouraged participation in yoga. External motivations, including physicians' recommendations, discounted sessions, improved comorbidities, and support

from family and friends, also positively influenced yoga practice in people with arthritis. Staying mentally motivated to practise yoga and consequently practising it led to perceived improvements in mental well-being, which, in turn, further reinforced the motivation to continue practising yoga.

Barriers

2a. Wavering intrinsic motivations (concentration, self-efficacy, and self-assurance) negatively influenced yoga practice.

Three findings (U) were merged to form this category, reflecting how the lack of intrinsic motivations among people with arthritis may hinder yoga practice. Those new to yoga practice described struggling with keeping their minds focused at the moment and were unsure about their yoga practice due to low levels of self-efficacy and self- assurance.

"I tried to do the exercise on Wednesday but I don't think I did very well. I need to keep my mind only on what I am doing…I tried to do a ten minute meditation. I was concentrating on just one sentence. It was hard to stay focus. I tried just seeing it in my head like a tie on tape but was hard. I don't know if I am doing this correctly." (Middleton, 2017, p86)

Facilitators

2b. High levels of intrinsic motivations (personal interest in yoga, prioritising health, self-efficacy, self-assurance, and self-confidence) facilitated yoga practice.

Eleven findings (U) were combined to create this category, illustrating how being intrinsically motivated might encourage yoga practice in people with arthritis. In this category, some people described that they were motivated to practice yoga due to their rising concerns towards health as they grew older, and some were enthusiastic to practice yoga out of personal interest. The ease with which yoga could be practised (minimal equipment and supervision) was perceived to increase self-efficacy and self-assurance in people with arthritis to practice yoga. They added that the high levels of intrinsic motivations provided a sense of accomplishment and bolstered their self-confidence in coping with their condition through continued yoga practice.

"I'm older now and I needed to do something about balance and posture." (Greysen, 2017, p490)

"I try to do it when I exercise I can and I want to learn them and that way I won't depend on the instructors, soon she will leave us alone and we will have to do it ourselves." (Middleton, 2017, p86)

"I was pretty proud of myself for getting through it. when I do certain moves, I can feel pretty good about myself." (Greysen, 2017, p491)

2c. Extrinsic motivations (doctor's advice, reduced price of yoga sessions, improvement in other health conditions, exposure to yoga, and peer/family support) positively influenced yoga practice in arthritis.

This category included seven findings (1C, 6U) describing the external influences that may motivate people with arthritis to practice yoga. These included yoga recommended by physicians to deal with pain, the provision of yoga at discounted prices, and perceived improvements in comorbidities (e.g., diabetes) were reported to encourage yoga practice in people with arthritis. Many expressed that awareness of, and exposure to, yoga and its benefits earlier in their lives would have equipped them mentally to deal with their pain in the long run. Support from friends and/or family was also cited as a motivation to practise yoga for arthritis.

"…God what a great thing to learn at a young age, because sometimes pain can be worsened because we're thinking about it too much so if you are in a position to

learn how to quiet that, it will help anything. If you can learn to do that when you are young, how much damage would you have in the long run?" (Evans, 2010, p910)

"A group of friends here at work had talked about doing Bikram yoga, and there was a deal, so I tried it." (Greysen, 2017, p490)

2d. Perception of improvements in mental well-being could encourage yoga practice.

This category included eight findings (U), which reflected on several perceived improvements in mental health due to yoga practice. They mentioned being able to "let go" of their worries, pain, and discomfort in arthritis and feeling calm and relaxed. Further, perceptions of improvements in their anxiety and depression symptoms were also generally reported. Many expressed feeling "happy" and experienced evident positive changes in their mood, which gave them the mental strength to deal with their condition.

"I am very grateful for doing yoga. I am more tranquil and I can sleep more because I practice breathing and letting go of everything in my mind." (Middleton, 2017, p86)

"The strength you have within yourself to make a difference." (Cartwright, 2020, p10)

3. Yoga, arthritis, and the mind-body impact: The experience of mind-body benefits of yoga fostered a positive outlook on coping with arthritis and encouraged ongoing engagement with yoga practice in people with arthritis.

This synthesised finding aggregated 23 findings into four categories. It explored the perceptions of people with arthritis regarding how practising yoga deepened their understanding of the link between their body and mind and imparted a sense of overall well-being. These perceived intertwined mind-body benefits of yoga provided a sense of empowerment and enabled people to take charge of their condition by positively shifting their perspective towards coping with the physical and mental aspects of their condition.

<u>Facilitators</u>

3a. Practising yoga gave people with arthritis a sense of empowerment, i.e., the ability to take control of their condition.

Five findings (U) were merged to create this category, which showed how people with arthritis perceived that yoga practice gave them a sense of agency to deal with their physical and

mental health in arthritis. They mentioned that yoga strengthened their mind-body connection and the mind-body benefits were influenced by each other, i.e., improved physical health (reduced pain) led to improved mental health (stress relief and feeling calm) and vice versa.

"It tuned me into coping, it tuned into my mind in how I deal with situations…I had to help myself which she taught me to do." (Cartwright, 2020, p24)

3b. Yoga was appreciated as a beneficial coping strategy for arthritis.

Twelve findings (U) were merged to form this category, which described the perceptions of people with arthritis on how yoga practice offers skill-based coping strategies to deal with the physical and mental aspects of the condition.

"My pain is still there...but now the difference is that I could reduce the pain by relaxing and just learning to be stress-free and just to be more peaceful. I've learned that if I'm peaceful and more stress free my pain eases away a little. So I'm doing better now." (Evans, 2010, p910)

3c. Practising yoga changed the way people with arthritis viewed their condition, allowing them to rediscover themselves and regain a sense of normalcy in their lives.

This category included three findings (U) illustrating how people with arthritis perceive yoga as a way to reconnect with themselves. They mentioned feeling a sense of calm and being able to distract their minds from the physical discomfort of arthritis. They added that the mind-body benefits enabled reconnection with their "self" (bodies and minds), making them more physically and mentally aware of their arthritis and changing their negative outlook towards dealing with the condition.

"I felt like I found this inner peace within me. I found a side of myself that I didn't know I had before…You let go of everything when you're there doing yoga…I forgot about the pain sometimes." (Evans, 2011, p7)

3d. Consistent yoga practice was perceived as essential for achieving long-term holistic benefits for arthritis.

Three findings (U) constituted this category, which showed how people with arthritis felt that to experience long-term holistic benefits of yoga, it was important to practise yoga regularly and incorporate it into daily routines, including practice at home.

"I think I need to stick with practicing yoga on a regular basis to improve symptoms long-term." (Evans, 2010, p911)

4. Yoga, arthritis, and session accessibility, and structure: Engagement with yoga practice was influenced by individually determined factors affecting access to sessions, as well as by the structural characteristics of the sessions.

This synthesised finding was generated from five categories developed from 22 findings. It described factors determining an individual's access to yoga sessions (e.g., logistical considerations) and the structural characteristics of a yoga session (e.g., yoga poses delivered and their difficulty level, suitable modifications offered in the sessions, pace of the sessions, qualities and professional training of the yoga providers, and availability of props and resources) that influenced yoga practice in people with arthritis.

Barriers

4a. Juggling with logistical challenges to attending yoga sessions discouraged yoga practice.

Five findings (U) were combined to create this category. Time constraints (e.g., difficulty prioritising yoga over other activities) and financial limitations (e.g., inability to afford

yoga sessions) were cited as common barriers to yoga practice among people with arthritis. Other responsibilities, such as caregiver or family commitments, were also perceived to hinder yoga practice in people with arthritis.

"I don't do a lot of yoga because of time restraints." (Cheung, 2022, p7)

"My disabled daughter continues to [need]a great deal…my husband got prostate cancer…" (Cheung, 2022, p7)

4b. Unsatisfactory yoga experiences, including the difficulty level of the practices and discomfort, hindered yoga practice.

This category consisted of two findings (U), which showed how the delivery of yoga sessions affected yoga practice. There was some description of yoga delivered in the sessions that was not modified adequately according to people's specific needs in arthritis, which made it physically challenging for them to practice yoga. The intrusive nature of the yoga therapist in a yoga therapy session, leading to stress and discomfort, was also highlighted as a barrier to yoga practice.

"It was really hard to bend my joints, I felt like it wasn't for me or people with arthritis." (Greysen, 2017, p490)

"It gave me so much stress…[The therapist] was trying to find out, like you know like something like, something in my life which has caused this thing." (Cartwright, 2020, p10)

Facilitators

4c. Yoga's adaptability and well-paced sessions to suit people's needs and preferences in arthritis were perceived to be helpful.

Six findings (U) were aggregated to create this category. Many people expressed their satisfaction about yoga being adapted and paced according to their needs, preferences, and capabilities in the sessions and its added advantage as a non-invasive and non-pharmacological option in arthritis treatment. They described how practising yoga tailored to their needs enabled them to accept their physical limitations and be more compassionate towards themselves, rather than feeling pressured to achieve a pose that might not suit their bodies.

"I wasn't overwhelmed, so I wasn't like, 'oh my gosh, this is too hard for me, I can't go back,' so, it was just my right pace." (Greysen, 2017, p490)

"Tailored the routine to suit me and how my health was at that time. If I couldn't do something because of a certain movement then we'd take that bit out." (Cartwright, 2020, p23)

4d. Availability of a yoga provider with positive qualities, knowledge, and professional training facilitated yoga practice.

Four findings (U) were grouped to create this category, highlighting the positive qualities of a yoga provider that drew people with arthritis towards yoga practice. People with arthritis emphasised the importance of yoga providers being empathetic and receptive towards individual needs and having adequate professional training to meet those needs safely.

"But for the person to have an understanding and knowledge…and empathy and to know, gosh, this person's got a problem with that joint; this is the alternative way of getting the same effect with this exercise." (Ward, 2011, p218)

"…the fear can be a problem. But as long as you trust the person that's actually teaching you, that, you know, they've got your well- being, best interests." (Ward, 2011, p218)

4e. The provision of props and resources was perceived to offer confidence and security for yoga practice.

Five findings (U) were combined to create this category, highlighting how the availability of props and resources served as facilitators to yoga practice in people with arthritis. Using props, such as a chair, to perform yoga poses provided support and safety, instilling confidence and a sense of security in their practice. In addition, guidance from resources such as DVDs and yoga instruction manuals made it easy for them to continue yoga practice, even outside the yoga sessions, at their convenience.

"I don't think I could do the yoga unless I had something beside me to help me. The chair yoga offers security for me." (Park, 2011, p323)

"Standing on the toes holding the wall, it is pretty good. I did the warm up looking at the book." (Middleton, 2017, p86)

5. Yoga, arthritis, and the session environment: A supportive social environment in yoga sessions, characterised by a welcoming space and meaningful connections, encouraged yoga practice in people with arthritis.

This synthesised finding was created from eight findings merged into two categories. It encompassed the positive impact of the social environment of yoga sessions, including safe, empathetic, non-judgmental, and supportive spaces that enabled people to form social connections, ultimately enhancing yoga practice in people with arthritis.

Facilitators

5a. Safe and supportive space (in group sessions) and a "therapeutic" space (in one-to-one sessions) were considered important for yoga practice.

Three findings (U) were combined to form this category, which highlighted the perceptions of people with arthritis regarding the positive influence of the environment of a yoga session. The availability of a safe, non-judgmental, supportive, and inclusive space in the yoga sessions was commonly cited as a major motivation to practice yoga for arthritis. One of them went for yoga therapy sessions and appreciated the "therapeutic" element in a one-to-one setting where the yoga therapist would pay close attention to individual needs and provide tailored modifications.

"I feel like it'll be more of a safe environment being that it's a study for arthritis and everyone in the class may have some issues." (Evans, 2011, p4)

"...they're not going to go [laugh], you know, what's wrong with you? You know, they already know what's wrong with ya..." (Ward, 2011, p218)

"It was a bit like a counselling session...where we would find triggers as to what is going on in my life, in my mind that would have a negative impact on my health, so pinpointing those areas and working on that, I feel has had a massive difference." (Cartwright, 2020, p23)

5b. Social connectedness in a group setting was perceived as a strong motivation for yoga practice.

Five findings (U) comprised this category. People with arthritis expressed that practising yoga in groups helped them connect with others having arthritis, strengthened their social bonds and fostered a sense of community, which reduced feelings of isolation.

"I just would be more motivated if it was with other people I knew, sort of understood how I felt, or, you know, like, yeah, I just want, wanna feel more comfortable with, even if they are strangers that they've got the same illness and stuff." (Ward, 2011, p215)

4.10 Discussion

4.10.1 Summary of main findings

This systematic review synthesised qualitative evidence on factors influencing yoga practice, with the categories within each synthesised finding offering insight into the barriers and facilitators to yoga practice in people with arthritis. These factors were related to the impact of yoga on physical well-being, the interconnectedness of maintaining mental well-being and staying motivated to practice yoga, the interlinked mind-body benefits of yoga, the structural characteristics of yoga sessions, and the influence of the social environment in yoga sessions.

4.10.2 Comparison with existing literature and implications for practice and research

Overall, this review suggested that yoga can be a positive and empowering experience, articulating a range of facilitators to regular yoga practice, and therefore highlighting its potential as a complementary approach to arthritis treatment. Nevertheless, several important barriers were also identified in this review. A key concern was the apprehension among people with arthritis about yoga practice, as they thought yoga might be beyond their physical capabilities and could worsen their condition. Media portrayals often depict yoga as a physically intensive practice with a risk of injury, potentially

discouraging yoga practice.[294] This review highlighted the need for future efforts to reduce fears surrounding yoga practice in people with arthritis. These findings highlight an opportunity for healthcare providers and policymakers to actively reshape public and patient perceptions of yoga. Incorporating evidence-based information about safe, adaptive yoga practices into arthritis education programmes could help normalise yoga as an accessible form of self-management. Partnerships between rheumatology services and trained yoga providers may also support the integration of yoga into community-based pathways for arthritis treatment.

This review found that intrinsic motivations, e.g., self-efficacy, self-assurance, and self-confidence, can act as both barriers and facilitators to yoga practice in people with arthritis. Low levels of intrinsic motivation were perceived as obstacles to yoga practice, whilst higher levels were perceived to facilitate it. Yoga practice was also perceived to enhance mental well-being, which in turn boosted intrinsic motivation, creating a positive self-sustaining cycle. This suggests that yoga interventions for arthritis should target intrinsic motivation and self-efficacy rather than solely focusing on physical outcomes. Applying theoretical frameworks such as Self-Determination Theory or Bandura's Social Cognitive Theory could enhance intervention design by addressing

motivational and psychological mechanisms underpinning sustained engagement.[295,296] This interconnected relationship highlighted the link between mental well-being and an individual's motivation to practice yoga for arthritis. This aligned with findings from a systematic review on physical activity (including a wide range of physical activity interventions, including yoga, suggesting that self-driven intrinsic motivations (e.g., self-compassion) could significantly enhance well-being and further encourage physical activity.[297]

This review highlighted improvement in arthritis symptoms, particularly pain relief, as a key motivator for practising yoga in arthritis. A narrative review suggested that yoga may improve pain tolerance and alleviate pain perception.[298] Further, systematic reviews have shown that yoga may help reduce joint stiffness and pain and improve function in osteoarthritis.[173,176,181,278,279] Our review supported these findings, also noting that reduced feelings of anxiety and depression as a result of yoga practice were perceived to make it easier for people with arthritis to cope with the mental burden of the condition. This reinforced evidence that yoga positively impacts mental health in rheumatic diseases, including arthritis.[159] Clinically, these insights support the inclusion of yoga as a complementary approach within

multidisciplinary arthritis care. Programmes that emphasise both symptom relief and emotional coping could enhance patient-centred outcomes and reduce reliance on pharmacological treatment alone.

A novel insight from this review was the perceived interplay between mind and body in yoga practice, leading to a sense of mind-body (holistic) benefits. The findings suggest that yoga was not viewed as merely a physical activity but as a practice also contributing to emotional and mental well-being. These synergistic, interconnected, and holistic benefits were a key facilitator underpinning yoga practice in people with arthritis. Accordingly, people with arthritis reported a changed outlook on their condition, a restored sense of normalcy, and a feeling of empowerment to take control of their condition. This resonated with findings from a qualitative study on patients' perceptions of practising yoga to manage chronic pain, in which participants felt that yoga reframed their perceptions of living with it.[299] Therefore, the review emphasised the importance of recognising and promoting yoga as a holistic practice, encompassing physical poses, breathing practices, and meditation and relaxation practices to obtain overall benefits in arthritis. This reinforces a paradigm shift from purely biomedical models of arthritis management toward holistic, integrative approaches that recognise the interplay

between mind and body.[300] Promoting yoga as part of a biopsychosocial model of care may empower patients to adopt active coping strategies and strengthen resilience.

In addition to health-related benefits, individually determined factors influencing access to yoga sessions, and several structural characteristics of the sessions were also perceived to influence yoga practice in people with arthritis. These included common barriers such as lack of time, financial constraints, and other responsibilities, similar to challenges reported in the general adult population.[301] While physical activity is essential for alleviating arthritis symptoms, people with arthritis can face particular barriers to staying active, poor adherence to exercise, limited guidance on injury prevention, and fears about exacerbating their condition.[302,303] These concerns can make it difficult to find a suitable form of physical activity.[304] Yoga may offer a valuable alternative, as it emphasises stretching, strength, posture, balance, and allows for adjustable pace and intensity, ensuring both health benefits and safety.[305]

This review found that the adaptability of yoga (e.g., using props) and the flexible pacing of sessions to accommodate arthritis-related needs and capabilities were key facilitators for yoga practice. This finding aligned with qualitative studies

emphasising yoga's ability to be tailored to meet the evolving physical and mental health needs in specific health conditions, including arthritis.[306-308] Beyond the practice itself, the review also underscored the important characteristics of the yoga provider. People with arthritis valued empathetic yoga providers who encouraged acceptance of physical limitations, a finding echoed by a qualitative study exploring UK-based yoga providers' insights on arthritis treatment, which is further discussed in Chapter Five.[307] Additionally, yoga sessions delivered by knowledgeable and professionally trained yoga providers capable of adapting practices to meet arthritis-specific needs were considered essential for ensuring safety and encouraging participation.[307] These findings have implications for workforce development and training. Establishing formal accreditation or continuing professional development modules for yoga providers working with chronic conditions, including arthritis, could improve the quality, safety, and consistency of delivery. Collaboration between healthcare systems and yoga organisations could help bridge the current gap between clinical guidance and community-based practice.

The social environment of yoga sessions was another key facilitator of yoga practice, synthesised in this review. A safe, supportive, and inclusive space where people did not feel

judged due to their physical limitations was perceived as crucial to encourage yoga practice. People with arthritis often desire social interaction but withdraw from social activities due to their symptoms, leading to isolation.[268,309] Group-based yoga sessions were perceived to engender social support and reduce feelings of loneliness in people with arthritis, thus facilitating yoga practice, and indicating that group-based yoga may hold added psychosocial value. This suggests that yoga could drive social participation, supporting broader public health goals around reducing isolation among people with long-term conditions. These review findings were consistent with prior research suggesting that the sense of community and connection fostered in group yoga settings reduces isolation and offers social support.[307,310]

4.10.3 Strengths and limitations of the systematic review

To my knowledge, this is the first systematic review to synthesise the barriers and facilitators to yoga practice in people with arthritis. The review followed JBI and PRISMA guidelines to ensure methodological rigour, and at least two independent reviewers were involved at each step to enhance credibility and minimise researcher and selection biases.[188,281] However, the review had some limitations. Access to the EThOS database was not possible due to an ongoing cyber-attack, limiting the retrieval of relevant UK doctoral theses for

this review. Only eight studies met the inclusion criteria, reflecting the limited availability of qualitative evidence in the evolving area of yoga and arthritis research. Additionally, the included studies were conducted in high-income countries, which may not be reflective of experiences from low- and middle-income settings, especially in the Indian subcontinent, where yoga originated and is formally recognised and widely practised. Therefore, our review findings might not be transferable to these contexts. The included studies focused only on common types of arthritis, limiting insights into factors affecting yoga practice in other types. More qualitative research is therefore needed to understand experiences across diverse arthritis types and broader geographical, socio-demographic, cultural, and healthcare contexts. Although a GRADE-CERQual assessment would have been appropriate for evaluating the confidence in the qualitative findings[311], it was not conducted due to time constraints during the PhD. Future research should consider applying GRADE-CERQual to strengthen the assessment of evidence certainty.

4.10.4 Implications for policy, practice, and future research

Taken together, this review underscores the potential of yoga as a holistic, self-empowering approach to arthritis treatment within contemporary health systems. Future health policy

could consider yoga as part of integrated care frameworks, with referral pathways enabling access for people with arthritis. Furthermore, future research should explore implementation in low- and middle-income countries and culturally diverse populations to ensure equitable access and global relevance. Mixed-methods and longitudinal studies could clarify causal mechanisms linking yoga practice to sustained physical and psychosocial outcomes, strengthening the evidence base for its clinical and public health adoption.

4.11 Conclusion

This review synthesised both barriers and facilitators to yoga practice in people with arthritis. Within the included studies, facilitators were somewhat more frequently reported than barriers, in line with the possibility that yoga could be a valuable addition to arthritis treatment. Key barriers included fear of injury, lack of motivation, and limited accessibility to yoga sessions. Physical, mental, and mind-body benefits of yoga were prominent facilitators. Further, yoga's adaptability, availability of professionally trained and empathetic yoga providers, and supportive group environments also encouraged yoga practice in people with arthritis. However, the evidence base is limited by a small number of studies, a narrow focus on specific arthritis types, and research predominantly conducted in high-income countries, which

limits the transferability of findings. Future research should therefore focus on addressing the synthesised barriers and enhancing facilitators, particularly in more diverse populations and settings, to support the successful implementation of future yoga interventions in arthritis treatment.

Chapter Five: Clinical knowledge, experiences, and perceptions of yoga providers in arthritis treatment: a UK-based qualitative study

5.1 Introduction

Chapters Two to Four of this thesis examined the evidence on yoga as a complementary approach for arthritis from both quantitative and qualitative perspectives. The systematic reviews synthesised the key content, structure, and delivery characteristics of effective yoga interventions for osteoarthritis and rheumatoid arthritis, and synthesised global qualitative evidence on barriers and facilitators influencing participation in yoga among people with arthritis. Collectively, these chapters highlighted yoga's therapeutic potential for arthritis but also underscored a critical implementation gap, specifically, the limited understanding of how yoga is currently delivered by yoga providers to people with arthritis in the UK. Building on the synthesis of barriers and facilitators to yoga practice among people with arthritis presented in Chapter Four, this chapter shifts focus to the insights of yoga providers, which may complement those findings.

In the UK, yoga is delivered by a range of providers with different levels of training.[146] These include around 10,000 yoga teachers[146] and nearly 150 yoga therapists with additional yoga training and experience in delivering yoga for specific health conditions[147]. Most yoga sessions are provided by yoga teachers who may have some clinical knowledge and experience in delivering yoga for health

conditions but may benefit from further yoga training to support people with specific health conditions, such as arthritis.[148]

Despite yoga's potential benefits in arthritis treatment and its increasing popularity, there is no evidence exploring the clinical knowledge, experiences, or perceptions of yoga providers in arthritis treatment. Yoga providers' insights as healthcare professionals would help identify and address the potential issues in recommending yoga in arthritis treatment and provide solutions to these challenges. Arthritis encompasses a variety of types, many of which share overlapping symptoms and health consequences, making it challenging to distinguish between them without a confirmed clinical diagnosis.[168] Therefore, to reduce complexity and ensure that yoga providers can deliver effective and inclusive interventions without needing to differentiate between the types of arthritis, this study focused on their insights regarding the delivery of yoga to individuals with any form of the condition. Hence, this chapter presents a qualitative study to explore UK-based yoga providers' clinical knowledge of arthritis, their experiences of delivering yoga to people with arthritis, their perceived role in arthritis treatment, and perceived yoga training needs.

Research question: What are the clinical knowledge, experiences, and perceptions of UK-based yoga providers in delivering yoga to people with arthritis?

5.2 Methods

5.2.1 Study design, philosophical paradigm, and research approach

A qualitative study underpinned by the constructivist philosophical paradigm was conducted utilising the phenomenological approach.[312,313] Constructivism is a philosophical paradigm that emphasises that individuals actively construct their unique perceptions of reality through cognitive processes leading to multiple, subjective realities.[312] It recognises that reality is socially constructed through interactions, knowledge, and lived experiences of individuals. Thus, an individual's perception of reality can only be fully understood through their unique personal experiences, which may differ from others due to differing historical and social contexts. Constructivist researchers rely on questioning and observation to gain a rich and in-depth understanding of the phenomenon being studied.[312] This study aimed to explore the knowledge, experiences, and attitudes of yoga providers in depth, employing a constructivist paradigm that aligns well with the aim. The constructivist paradigm primarily utilises qualitative research designs and methods to explore the depth,

richness, and complexity of human experiences, which are often challenging to measure using quantitative approaches.[312]

With this paradigm, common qualitative research approaches include grounded theory, phenomenology, and observational research.[312] Grounded theory focuses on developing new theoretical insights by identifying patterns and relationships within data through constant comparison. Observational research involves observing and recording participants' natural behaviours to understand real-world dynamics. Phenomenology, on the other hand, seeks to understand individual lived experiences by analysing participants' descriptions and revealing underlying meanings and structures, and involves inductive analysis to extract meaning from patterns that emerge across participants' accounts.[313] As this study aimed to explore the unique experiences and perceptions of yoga providers, rather than to develop a theory or observe changes in the experiences and perceptions of yoga providers in delivering yoga to people with arthritis in real-life settings, phenomenology was selected as the most suitable research approach.

5.2.2 Data collection method

Among the various qualitative data collection methods, focus groups and in-depth interviews are most commonly used.[314]

Each has distinct advantages and limitations. Focus groups facilitate diverse responses through group interaction, but discussions may be influenced by dominant voices (e.g., one respondent might dominate the discussion), which can discourage some participants from sharing differing perspectives. In contrast, in-depth interviews, though more time-consuming, are well-suited for building rapport, clarifying questions, and eliciting elaborate and personal accounts of participants' knowledge, experiences, and perceptions.[314] Given the exploratory nature of this study, in-depth interviews were chosen as the data collection method.

In-depth interviews can be conducted in structured, semi-structured, or unstructured formats. Semi-structured interviews offer the flexibility to explore new areas of interest while still addressing pre-determined topics.[314] This format encourages open dialogue between the interviewer and participant, enabling deeper exploration of the topic, clarification of participant responses, and identification of novel themes. For these reasons, semi-structured interviews were used in this study.

5.2.3 Study location, year, and reporting

This study was conducted in the UK in 2023 and was reported according to the Consolidated Criteria for Reporting Qualitative Research (COREQ-32) guideline.[315]

5.2.4 Eligibility criteria and participant recruitment

Eligible participants were UK-based yoga providers (teachers and/or therapists) who delivered yoga sessions to people with arthritis, aged 18 years or older, at least once a fortnight within the six months preceding the recruitment date, in any setting within the UK. UK-based yoga providers were selected as participants to explore yoga delivery within the UK context, where regulatory, cultural, and healthcare system factors are unique. A purposive sampling approach was used to identify and recruit participants based on their willingness to participate. This approach was chosen to ensure the inclusion of yoga providers with relevant experience in delivering yoga to people with arthritis. They were contacted through professional yoga associations in the UK. Briefly, five yoga associations were approached to circulate the study poster with information about the study and contact details of the lead researcher and PhD student, trained in qualitative research methods, and two agreed, namely, British Wheel of Yoga (BWY) and Yoga Teachers Together (YTT) (previously Independent Yoga Network (IYN)). Twenty-two yoga providers were initially interested and contacted the lead

researcher, but two did not respond to the follow-up emails. The participant information sheet and consent form (Appendices 8 and 9, respectively) were shared with potential participants via email, and the lead researcher answered their questions if they had any. They were given at least 24 hours to decide to participate in this qualitative study, and the date for the interview was then arranged. Before conducting interviews, written informed consent was obtained from each participant. Further verbal consent was obtained at the beginning of the interview. Participants were informed that transcripts would be anonymised and handled confidentially, and that they were free to pause, skip any questions, or withdraw from the interview at any time, if they wished to do so.

5.2.5 Sample size

The sample size guideline for qualitative research using semi-structured interviews suggests that 20 to 30 interviews are adequate for achieving saturation of themes (i.e., the point at which no new or relevant themes emerge from the data that address the research question).[316] Saturation is often described as the point in data collection and analysis when emerging data yield little or no new information to address the research question.[316] Although saturation of data was reached by the 17th interview in this study, data collection was continued

until the 20th interview to ensure that no new relevant insights were missing.

5.2.6 Interview guide

The lead researcher developed the interview guide in consultation with two senior researchers based on the study's aim and the existing relevant literature, through repeated discussions (Appendix 10). Probing questions were included to encourage the yoga providers to share their opinions freely. For pre-testing, the interview guide was discussed with a UK-trained yoga teacher for her feedback. However, no major adjustments were required. UK-based yoga providers were selected as participants to explore yoga delivery within the UK context, where regulatory, cultural, and healthcare system factors are unique. Healthcare professionals were not included because the study aimed to explore the experiential knowledge and perspectives of yoga providers, which differ from clinical expertise. Yoga providers are key stakeholders in decisions about yoga delivery for people with arthritis, and no prior UK-based research has explored their insights. The interview guide broadly included the following three sections: (i) what do yoga providers know about arthritis, its treatment, and the potential benefits of yoga for people with arthritis; (ii) what are their experiences in delivering yoga to people with

arthritis; and (iii) what are their perceptions to delivering yoga to people with arthritis.

5.2.7 Interview procedures and transcription

Once the interview date, time, and mode (online through Microsoft Teams or in-person) were finalised, the interviews were conducted by the lead researcher in English using the interview guide. Based on participant preference and feasibility, all interviews took place online via Microsoft Teams. All interviews were digitally recorded using Microsoft Teams with the participants' (yoga providers') consent. In addition, research notes were maintained to facilitate preliminary coding. Participants turned on their cameras during the interviews, which allowed the lead researcher to engage more with the participants and to observe their non-verbal expressions for data analysis and interpretation. Participants received a £10 online shopping voucher for their time post-interview. Two interview recordings were transcribed verbatim by the lead researcher for familiarisation with the data. An external company transcribed the remaining interview recordings after signing the non-disclosure agreement. The lead researcher repeatedly listened to the interview recordings, constantly comparing them to the transcripts to add any missing data and correct any inaccuracies. All transcripts were anonymised by

removing identifiable information and labelling each transcript with a number.

5.2.8 Ethics approval

Research ethics approval was obtained from the Faculty of Medicine and Health Sciences Research Ethics Committee, the University of Nottingham, UK (Reference number FMHS 40-0722) (Appendix 11). The study title used in the ethics approval form, participant information sheet, and consent form differs slightly from the final chapter title and the manuscript due to refinement of the research focus during the PhD process.

5.2.9 Data storage and protection

Only the minimum information required for the study was collected and stored securely in OneDrive by the lead researcher, with access to these documents being limited to the researchers involved in this study. These included field notes, consent forms, interview recordings and transcripts. Each participant was assigned a study identity code to maintain confidentiality. The researchers took appropriate measures to uphold participants' rights to privacy and informed consent, in accordance with the UK General Data Protection Regulation (2021). This involved providing participants with clear information about data privacy and

implementing suitable safeguards for secure data storage and handling.

5.2.10 Data analysis

Interview transcripts were imported into NVivo 13 software to facilitate data storage and organisation for analysis.[317] Data were analysed using the thematic analysis approach of Braun and Clarke.[318] This followed several steps: (i) familiarisation through multiple readings of the interview transcripts, (ii) line-by-line inductive coding, i.e., assigning codes to units within the data, (iii) combining the codes into sub-themes after discussion with senior researchers, and (iv) interpreting and organising the codes into over-arching themes.

To enhance analytical rigour and consistency, the first five transcripts were independently double-coded by two researchers, followed by a comparison and discussion of codes to ensure shared understanding of the coding framework. The remaining transcripts were coded by the lead researcher, using the agreed-upon coding structure, with regular discussion and peer debriefing with senior researchers to refine and validate emerging themes.

The themes were refined on two levels - primarily with the coded data, ensuring they formed a coherent pattern. Next, the

emergent themes were organised in an analytical order such that there was a connection between themes, accurately reflecting the complete data. Each theme was described with anonymised participant quotes that best supported them (represented by “T” and “Th” for yoga teachers and yoga therapists, respectively). Quotes reported were verbatim unless indicated by an ellipsis (…) to indicate that small sections of text were removed for clarity.

5.2.11 Reflexivity

The lead researcher had no prior acquaintance with the participants and was not familiar with yoga practice in the UK but had some experience as part of her formal education in India. Both senior researchers involved in the analysis had significant experience in evidence-based healthcare research; one of them had an educational background in Ayurveda (including yoga) from India. Reflexivity was actively maintained as a continuous process throughout data collection and analysis. As a research team, we recognised that our own backgrounds and experiences could shape our engagement with the data. Strategies included reflexive journaling by the lead researcher to document preconceived notions and monitor how these evolved during analysis. Team discussions and peer debriefing further helped us identify and reflect on our assumptions, backgrounds, beliefs, and prior

experiences, thereby minimising potential biases and ensuring a balanced interpretation of the findings. These practices enhanced transparency and trustworthiness by ensuring that data interpretation accurately reflected participants' insights rather than our own expectations.

5.3 Results

5.3.1 Interviewees' characteristics

Twenty UK-based yoga providers were interviewed online, including 16 yoga teachers and four yoga therapists. Most of them were females (n = 19) aged 45 to 64 years (n = 16). Most of them had a diploma in yoga (n = 16) and their yoga delivery experience ranged from 11 months to over 50 years. The interviews had a mean duration of 43 minutes, ranging from 27 minutes to 70 minutes. Yoga providers' self-reported characteristics are detailed in Table 23.

Table 23 Interviewees' self-reported characteristics.

Characteristics	**N**
Yoga providers	20
Yoga teacher	16
Yoga therapist	4
Sex	
Female	19
Male	1
Age group, in years	
25-44	2
45-64	16
65 or more	2
Yoga training received[a]	
Certificate	10
Diploma	16
PG certificate	3
PG diploma	3
Other	2
Yoga delivery experience (range)	11 months to over 50 years
Style of yoga[a]	
Hatha yoga	9
Vinyasa yoga	3
Ashtanga yoga	1
Other	10
Major content of yoga sessions[a]	
Asana (yogic poses)	20
Pranayama (breathing practices)	19
Dhyana (meditation) and relaxation practices	20
Structure of yoga sessions[a]	
Group	20
One-on-one	14
Yoga settings[a]	
Yoga class	19
Yoga workshop	6
Attendees' home	5
Outdoors	6
Other	15
Terminology from other language used in yoga sessions[a]	
Sanskrit (for explaining yoga philosophy and names of yogic practices)	9
Scottish	1

[a]Participants chose more than one option.

5.3.2 Thematic analysis

Eight themes and 22 subthemes were identified (see Table 24).

Table 24 Themes and subthemes.

Theme	Subtheme
1. Awareness and clinical knowledge of attendees' health conditions, including arthritis, and its treatment	1.1 Awareness of attendees' health conditions 1.2 Clinical knowledge of arthritis, its treatment, and limitations
2. Experiences in delivering yoga to attendees with arthritis and their perceptions of arthritis treatment shaped by these experiences	2.1 Experiences of modifying yoga for attendees with arthritis 2.2 Perceived confidence level in delivering yoga to attendees with arthritis 2.3 Perceived importance of their role in arthritis treatment
3. Perceived benefits of yoga for attendees with arthritis	3.1 Yoga as a better alternative for movement compared to other forms of physical activity 3.2 Improved physical and mental well-being 3.3 Improved social well-being 3.4 Potential role of yoga as a part of arthritis treatment
4. Perceived beneficial components of yoga in arthritis treatment	4.1 Yogic poses help mobilise the joints 4.2 Breathing practices, and meditation and relaxation practices work together to release mental stress 4.3 Yogic poses, breathing practices, and meditation and relaxation practices are interrelated in imparting mind-body benefits in arthritis
5. Perceived importance of the yoga environment and yoga provider qualities in arthritis treatment	5.1 Creating and maintaining a positive environment 5.2 Yoga provider qualities for delivering yoga to attendees with arthritis
6. Attendee-level concerns perceived as challenges for yoga delivery in arthritis treatment	6.1 Logistical challenges 6.2 Apprehensions about trying yoga among attendees with arthritis 6.3 Lack of acceptance of physical limitations among attendees with arthritis 6.4 Limited awareness of yoga among attendees with arthritis
7. System-level concerns perceived as challenges for yoga delivery in arthritis treatment	7.1 Unregulated nature of yoga delivery 7.2 Limited available scientific evidence on the use of yoga in arthritis treatment

8. Professional yoga training obtained and perceived yoga training needs in arthritis treatment	8.1 Professional yoga training and qualifications obtained 8.2 Perceived yoga training needs in arthritis treatment

1. Awareness and clinical knowledge of attendees' health conditions, including arthritis, and its treatment

1.1 Awareness of attendees' health conditions

Yoga providers generally gathered information from the attendees about any health issues they had when attendees joined their sessions for the first time, verbally, or through a written health questionnaire. For those with arthritis, being aware of the affected joints and if they have had any surgery (e.g., hip replacement surgery) was perceived to help identify the specific yoga practices that might be contraindicated, thus ensuring the attendees' safety.

"You get them to fill in a health questionnaire before they come and see you. on that form…it's got tick boxes…and then I'll have a bit of discussion with them…"(T5)

Yoga providers reported a wide range of health conditions disclosed by the attendees, including diseases of the eye, endocrine, nutritional, and metabolic diseases (e.g., diabetes), diseases of the circulatory system (e.g., hypertensive diseases, heart diseases), and diseases of the musculoskeletal system, which included arthritis, clinically diagnosed or undiagnosed.

"It's a range of issues, arthritis, including rheumatoid and osteoarthritis…just general, from cancer to they've had strokes, fibromyalgia, chronic fatigue, eye issues, there's a whole host..." (Th3)

Many yoga providers mentioned that some attendees expected joint issues due to ageing and assumed it to be arthritis.

" ...I think people get to an age and think, "I've got dodgy knees now" but I don't think they've actually got it formally diagnosed…" (T15)

1.2 Clinical knowledge of arthritis, its treatment, and limitations

Yoga providers were fairly knowledgeable about arthritis including its types, signs and symptoms, causes, and mechanisms contributing to joint damage in major types.

"…So osteoarthritis is probably the one…the shape of the bone end changes…the cartilage process degeneration and regeneration is sort of disrupted…rheumatoid arthritis is an autoimmune condition so there's a mechanism where the body itself is attacking the joints…it creates inflammation and swelling and change of shape of joint again, it tends to go through episodes or flare-ups…" (T2)

They mentioned that their attendees with arthritis were generally females aged 50 or over, with painful, stiff, inflamed joints and limited mobility being the most commonly reported symptoms. They reported that attendees with a clinical diagnosis of arthritis in the knees, hips, or spine joints generally had osteoarthritis and joints in the wrists and fingers were typically affected by rheumatoid arthritis. Yoga providers highlighted the "vicious cycle" in arthritis in which people undertake less movement due to persistent pain, which further worsens the condition. Some yoga providers knew about the treatment strategies offered by the NHS for arthritis and their limitations, e.g., medications and surgical treatments and their side effects, and NHS physiotherapy service and related concerns.

"The NICE pathway is to first diagnose and then it used to be steroids, prednisolone was the first point of call but I'm seeing people are given hydroxychloroquine and for extreme cases, they give TNF, methotrexate and other biologics which obviously have side effects. When the disease gets into remission, the TNFs are removed and they are on low-dose steroids. They give a lot of steroid shots, injections into the knee before they go into the knee replacement option." (Th1)

They generally described the arthritis treatment approach of the NHS as more "reactive" than "proactive", i.e., predominantly medication-oriented to control symptoms, rather than focusing on providing lifestyle advice or non-pharmacological treatment for symptom prevention.

"...I think it's more symptom control rather than prevention that they tend to promote. So when they're seeing somebody, they've already got a lot of pain and maybe lost function and mobility by the time they're actually seen by the NHS..." (T13)

2. Experiences in delivering yoga to attendees with arthritis and their perceptions of arthritis treatment shaped by these experiences

2.1 Experiences of modifying yoga for attendees with arthritis

Yoga providers were aware of how arthritis manifests in individuals differently at different times. So, they emphasised that it was important to encourage attendees with arthritis to "listen to their bodies" and offered modifications (e.g., using props) based on feedback from their attendees and health questionnaires.

"I've got chairs for some people if they want to use a chair for balance…if they want to sit on something like blankets or bolsters…and maybe a couple of yoga blocks…you can also do that standing against the wall so that you're moving the spine but without weight on the knees or the wrists…" (T3)

Yoga teachers shared their experiences of how they tried to keep their sessions inclusive by modifying yoga using a risk-averse approach to meet the needs of all attendees, including those with arthritis. Yoga therapists, however, strongly preferred delivering modifications that were "goal-focused", i.e., catering to what the individual wants to achieve, depending on their needs and capabilities, in one-to-one sessions.

"For arthritis patients, I think the yoga that works is therapeutic yoga, that doesn't strain their joints and it's unachievable in a group session because the students have to do the practice based on what the teacher is designing. So for me, for arthritis, one-to-one yoga is the best option…" (Th1)

2.2 Perceived confidence level in delivering yoga to attendees with arthritis

Most yoga providers were reasonably confident in delivering yoga as they were aware and observant, trying to pre-empt the fluctuating needs of attendees.

"I think I'm fairly confident because I always check how the person's feeling, because arthritis can vary daily…so I'm mindful of the weather, the climate, how people are feeling on the day…" (T13)

Some of them mentioned that they were confident in delivering gentle movements as long as the attendees took control of their movement and did not push beyond their capabilities.

"…ultimately the student is in control…my students should be comfortable enough to know to stop or put their hand up and say, "No I can't,"...so I'm confident as long as I can trust them to be confident to tell me then yeah, they're not going to come and do any harm…" (Th2)

Some yoga providers expressed challenges in dealing with arthritis- specific medical queries of the attendees.

2.3 Perceived importance of their role in arthritis treatment

Most yoga providers felt their role was important in supporting and empowering their attendees with arthritis to take charge of their condition and ensure their overall well-being in arthritis.

"...I think it's being more as a facilitator…sometimes their confidence has been knocked, or there's a lot of the frustrations…with the social aspect and that disabling aspect." (Th3)

Yoga therapists, in particular, perceived their role in arthritis treatment was important only if attendees were consistent in their yoga practice and engaged with the yoga therapist through regular feedback to seek adequate support.

"Yoga practice will only work if the patient is active in their healing so I can design as many practices as I want, if the patient doesn't go and do those practices at home regularly, nothing will work. So it's like a partnership between me and the patients." (Th1)

3. Perceived benefits of yoga for attendees with arthritis

3.1 Yoga as a better alternative for movement compared to other forms of physical activity

Yoga providers shared that many attendees with arthritis enjoyed and appreciated yoga practice over exercise or gym workouts, as they were looking for a slow-paced, quieter, safer, comfortable, and beneficial alternative for movement.

"A regular exercise class because it's too fast, too many people, too difficult…they don't like the gym atmosphere, some people tell me they prefer to be in more, different space, not so many people there…" (T8)

They felt that the "subtle" aspect of yoga enabled the attendees to explore their deep intentions, serving as an escape from daily life stresses, which was not generally the case for exercises or workouts. They also appreciated that yoga practice generated a sense of "acceptance" of their bodies and compassion towards their condition enabling them to focus on what they could do in yoga.

"…I think this idea of having a little bit more appreciation of that idea of befriending and being compassionate towards the health condition…" (Th3)

3.2 Improved physical and mental well-being

Yoga providers spoke about positive feedback received from their attendees with arthritis regarding physical health,

including relief from painful, stiff, and inflamed joints, reduced muscle tension, increased flexibility, and improved mobility.

"…improved function, better movement of joints, feeling more mobile, being able to perhaps walk further or to feel a bit stronger…" (T2)

Yoga providers mentioned that practising yoga diverted attendees' minds from constant pain and stiffness in joints, making their perception of their symptoms less disruptive, thus reducing stress and improving mood, eventually contributing to mental well-being.

"…when you sleep better you're so much more able to manage your pain and again for the mental health benefits that breathing and meditation give you, it's respite from the pain." (Th2)

3.3 Improved social well-being

Yoga providers highlighted that attendees with arthritis were mostly older and may often feel isolated due to their pain and lack of mobility. Therefore, engaging in yoga practice with fellow attendees with arthritis was perceived to provide an opportunity to forge social connections and increase social

interactions with their peers and yoga providers, generating a sense of "community".

"It can be very isolating not having the full mobility and people will talk to each other, so I think that shared experience is really helpful for people…" (Th3)

3.4 Potential role of yoga as a part of arthritis treatment

Yoga providers discussed that many attendees practised yoga to improve their ways of dealing with arthritis on a day-to-day basis by maintaining the benefits in their daily lives "off the mat", i.e., even after the sessions were over.

"…nobody's looking to come to yoga as a cure for arthritis, but people are looking to yoga for ways to help improve how they experience their arthritis on a daily basis." (T14)

Many yoga providers generally agreed that, given its multitude of benefits, yoga could play an additional role in arthritis treatment, alongside other treatments, making it easier for the attendees to cope with their condition.

"…I would never say to somebody, "Oh don't bother taking your medication or taking what the doctor has prescribed"

and using yoga in isolation. I think it's a good tool as an additional part of a healthcare routine…" (Th3)

4. Perceived beneficial components of yoga in arthritis treatment

4.1 Yogic poses help mobilise the joints

Yoga providers often highlighted the importance of practising "gentle" or "micro" movements in yogic poses to lubricate and strengthen the joints and keep the muscles flexible, which was perceived to relieve pain and discomfort in arthritis.

"…motion is lotion, lubricating the joints keeping things moving and keeping the muscles flexible as well and strengthening the joints…" (T3)

Some yoga providers elaborated and some even demonstrated the yogic poses that they thought were helpful in arthritis and delivered in their sessions, such as Sukhasana (easy pose), Balasana (child's pose), Padahastasana (forward bend pose), and Virabhadrasana (warrior pose).

"The warm-up one, Sukhasana with props, Balasana, so going forward again with props, towels and things under them…we do twists but with variations in where the leg is

placed, so by the side of the thigh or taking it over, depending on how the hip joints are feeling…we do Trikonasana, Virabhadrasana I, II, Padahastasana, the forward bend, Dhanurasana, Setu Bandhasana, do a lot of Cat and a lot of strength work…" (T10)

4.2 Breathing practices and meditation and relaxation practices work together to release mental stress

Yoga providers mentioned that breathing with complete awareness, i.e., experiencing the temperature of the breath, deepening the inhalations and exhalations, and noticing the changes in the body consciously through meditation and relaxation practices, seemed to help the attendees with arthritis by distracting their minds from persistent pain, releasing mental stress, and generating a "calming effect".

"I think mindfulness of the breath is very helpful…focusing on the breath, meditation practises and relaxation are very important to help de-stress people and if they've got an inflammatory condition then the relaxation helps to balance the autoimmune system because…when people get over-stressed then that's going to heighten the sympathetic nervous system, whereas the relaxation then brings and strengthens

the parasympathetic response to calm everything down…" (T3)

Several yoga providers mentioned delivering Ujjayi pranayama (victorious breath) and Anuloma Viloma pranayama (alternate nostril breathing), which were perceived to be helpful in arthritis.

"...I'd tend to use Ujjayi and think about working with the exhalation, Nadi Shodhana, Anuloma Ujjayi, inhale both nostrils, exhale one..." (T2)

4.3 Yogic poses, breathing practices, and meditation and relaxation practices are interrelated in imparting mind-body benefits in arthritis

Yoga providers generally mentioned yoga to be a holistic practice, i.e., the interplay between its components seemed crucial to experiencing mind-body benefits in arthritis. Focusing on the breath, while being aware of the body and mind and feeling relaxed was perceived to encourage the attendees to practice yogic poses at their own pace.

"...the breath work, the meditation, releasing the stress and the anxiety of life and to relax, understanding how to go within, listen to yourself and then once you've understood

those stepping stones then the asanas can be very useful to arthritis…" (Th4)

5. Perceived importance of the yoga environment and yoga provider qualities in arthritis treatment

5.1 Creating and maintaining a positive environment

Yoga providers expressed that it was important to create a "safe and supportive space" for the attendees with arthritis in the yoga sessions, where they could practice yoga without feeling judged about their unique needs and capabilities.

"It becomes social as well as exercise and I promote the non-competitive aspect of yoga that the only competition is against your own body…" (T11)

Yoga therapists highlighted that it was important for them to establish a "therapeutic relationship" with their attendees with arthritis so that they could trust their yoga therapist and comfortably practise yoga.

"…there's a crucial element of a therapeutic relationship that's built between the therapist and them, where they feel safe, they feel non- judged…" (Th1)

5.2 Yoga provider qualities for delivering yoga to attendees with arthritis

Yoga providers were passionate about meeting the needs of the attendees with arthritis as they talked about the importance of being empathetic and compassionate towards their attendees' needs.

"…the students need to be seeing a therapist who will design a practice which is based on their needs and capacity and takes into account all the other factors that are causing the disease for them…" (Th1)

They shared that it was important to encourage their attendees to accept their physical limitations and enable them to practise yoga with a non-competitive approach.

"…I'm there to help him understand his mind, to understand how to calm down, understanding that it's okay to be not okay…being able to accept and just not concentrate too much on other people." (T16)

6. Attendee-level concerns perceived as challenges for yoga delivery in arthritis treatment

6.1 Logistical challenges

Yoga providers had a common consideration regarding the timing of yoga sessions, as attendees with arthritis tended to be more limited physically in the mornings, so yoga sessions conducted later in the day might be better suited for them.

"...a lot of arthritic people find it quite difficult to get started in the morning..." (T7)

Another concern raised was maintaining a warm temperature at the yoga venues to help the attendees with arthritis keep warmth in their inflamed joints. A yoga therapist noted that most of her attendees with arthritis were older with multiple health conditions and therefore prioritised medical appointments for other health conditions and often missed their yoga therapy sessions for arthritis.

"...arthritis patients have not just got arthritis, they've also got diabetes, they've got hypertension, they've got XYZ...so the logistics of coming to another appointment sometimes becomes a challenge for them." (Th1)

6.2 Apprehensions about trying yoga among attendees with arthritis

Yoga providers expressed their difficulty in motivating attendees with arthritis, especially older attendees, to get them to try yogic poses, due to their fear of worsening pain.

"…the main challenge is fear through pain…there's some people I just can't persuade to kneel, for example. I think that people find it hard to trust their bodies." (T4)

Some yoga providers felt that attendees with arthritis were hesitant to practice yoga as they were influenced by the inaccurate and unrealistic media representation of what yoga is, e.g., people with lean bodies practising complex poses such as Sirsasana (headstands).

"...some people would be scared of yoga because I think sometimes yoga has this perception, especially if people look online and see all these lovely thin, young, yogis doing all these headstands and crazy stuff..." (T6)

6.3 Lack of acceptance of physical limitations among attendees with arthritis

Yoga providers shared that attendees with arthritis were reluctant to accept their physical limitations and ended up practising yogic poses that might be beyond their physical capabilities at the time of practice.

"The biggest challenge is people not accepting their limitations…I'll say, "we're going to come down into a slow squat, any problems with your knees, just sit down" and they will still try and do a squat, even though they've been told they shouldn't be doing it…" (T15)

6.4 Limited awareness of yoga among attendees with arthritis

Yoga providers highlighted that there was limited awareness of yoga among those with arthritis, leading to a sense that yoga may not be suitable for them. Hence, yoga providers suggested that adequate promotion of yoga through healthcare professionals and relevant organisations supporting people with arthritis might help increase awareness and accessibility to yoga for people with arthritis.

"…I think the challenge is around promotion to the right groups of people…so possibly if we could link in with maybe organisations like Versus Arthritis or other charities or other chronic pain groups and link in more with health professionals, I think that would help to increase accessibility…" (T14)

"...most GPs are not going to be recommending yoga to people with pain, which is a real shame." (T13)

7. System-level concerns perceived as challenges for yoga delivery in arthritis treatment

7.1 Unregulated nature of yoga delivery

Most yoga providers highlighted the lack of regulation of yoga delivery in the UK as a common concern. They spoke about how this meant that yoga sessions might be delivered by those having no formal yoga training, making yoga practice unsafe for attendees with arthritis, resulting in injuries. Therefore, yoga providers suggested that yoga delivery should be regulated for the credibility of the yoga providers and the attendees' safety.

"I think because it's an unregulated industry...there's a perception of people that come to yoga classes that the yoga teacher is trained to a particular level or in a particular way...there is a need for regulation of the industry, because we are working with some quite significant health issues...so, just in terms of the safety aspect." (T13)

7.2 Limited available scientific evidence on the use of yoga in arthritis treatment

The yoga providers spoke about referring to the available traditional yoga resources for delivering yoga to people with arthritis. Some of them explored published research on the use of yoga for arthritis to gain or update their knowledge (e.g., ideas on making modifications to yogic poses) and found limited scientific evidence. Thus, they highlighted the need for more scientific evidence on using yoga for arthritis treatment.

"I'm not confident that there's much yoga research out there because it's all traditional books of somebody from a long time ago says that this pose will be good for this body part. If there was a scientific document talking about it, I might then look into it if I had people with that issue." (T5)

8. Professional yoga training obtained and perceived yoga training needs in arthritis treatment

8.1 Professional yoga training and qualifications obtained

All yoga providers obtained general yoga teacher training, which included some training on delivering yoga for joint conditions (not necessarily specific to arthritis) and was focused on helping the attendees make "gentle" movements. A few of them completed additional training courses, which

incorporated details on arthritis types and aspects of yoga that can be done in seated positions (e.g., chair yoga) for people with arthritis. Four yoga teachers acquired specialised yoga therapy training to become yoga therapists.

"I did a personal trainer qualification and then I did a supplement to that, which was called Teaching Fitness for Long Term Conditions, so that did cover osteoarthritis and rheumatoid arthritis…" (T4)

Yoga therapists emphasised that their yoga therapy training was not specific to a health condition and instead equipped them with the tools of yoga to meet the attendees' unique health needs in any health condition, including arthritis.

"…we didn't look specifically at conditions to fix because it's much more about internal, the client having that inner feeling and wisdom…if you've got, it's about listening into your own body, so it was less about this is what you would do for this because everyone's different…" (Th2)

8.2 Perceived yoga training needs in arthritis treatment

Although the information provided during yoga teacher training was adequate to deliver yoga sessions for any health condition, including arthritis, yoga providers were keen on

further arthritis-specific training using the best available scientific evidence. They suggested specialised training, such as continual professional development (CPD) courses or hourly workshops, would be helpful to gain or update their knowledge on arthritis and deliver safer modifications to yoga practices based on attendees' unique needs and capabilities in arthritis. They suggested that the specialised yoga training could include the pathophysiology of different types of arthritis and evidence-based information on the yoga practices that might be helpful in arthritis, strategies to provide hands-on modifications to these yoga practices, the rationale behind those modifications, and contraindications, if any.

"Understanding the differences between the two conditions and understanding the causes and the effects and then going through the modifications that you can make it safer and enjoyable for the person…" (T7)

"...I would like more hands-on work, where I can stretch someone's back and we'd do it very gently and decide that works for their body…" (Th2)

"...there's probably more room for us to learn more about how to adapt yoga to suit people's mental health needs…" (T14)

5.4 Discussion

5.4.1 Overview of findings and their interpretation

This study provided novel insights into the clinical knowledge, experiences, and perceptions of yoga providers in delivering yoga to attendees with arthritis in the UK. We found that the yoga providers were fairly knowledgeable about arthritis, its types, signs, symptoms, causes, mechanisms, and treatment. They were reasonably confident in delivering yoga to attendees with arthritis and perceived their role to be significant in supporting these attendees by helping them take charge of their condition. Our findings revealed varying levels of confidence in modifying yoga for people with arthritis. Specifically, yoga therapists meticulously tailored yoga practices to individual needs, whereas most yoga teachers adopted a more generalised, risk-averse approach to ensure safety, while maintaining inclusivity in the sessions. They perceived yoga to have many interrelated mind-body benefits in arthritis, which included physical, mental, and social well-being. They highlighted the importance of a safe and supportive environment in the yoga sessions, where each attendee feels comfortable practising yoga without being judged for their individual needs in arthritis. They were cognisant of the lack of awareness of yoga among attendees with arthritis and their apprehensions

about trying yoga for their condition. Their major challenge was the lack of regulation of yoga delivery in the UK. The availability of scientific evidence on the use of yoga for arthritis was also generally felt to be limited by the yoga providers. However, they suggested that accessibility to further arthritis-specific yoga training provisions using the best available scientific evidence would be helpful in arthritis treatment.

Yoga providers in this study perceived that yoga was helpful in arthritis as it could be modified using a gentle approach to suit the attendees' changing needs and capabilities. The adaptability of yoga to individual needs was found to be helpful, especially for people who generally tend to be physically limited due to musculoskeletal conditions, including arthritis, as suggested by findings from a systematic review.[175] Our findings highlighted yoga providers' perceptions of the interlinked mind-body benefits of yoga, imparting overall well-being in arthritis. Existing literature suggests that yoga practice tends to increase body awareness, reduce pain perception and mental stress, and improve overall well-being.[319,320] Social support conferred by yoga practice was identified by yoga providers in our study to be helpful for attendees with arthritis, as it made them feel socially connected. Similarly, a qualitative study exploring yoga's

impacts on individuals' social well-being highlighted how yoga practised in groups helped increase positive social interaction and overcome isolation.[310] Underlining yoga's wide range of perceived benefits, our findings add to evidence suggesting that yoga could have a role in alleviating arthritis symptoms in addition to standard treatment.[184,247,280,291]

A key theme in our study described yoga providers' perceptions of how yoga is delivered. Delivering yoga in a safe and supportive space and the yoga providers' ability to be responsive and compassionate towards attendees' needs were perceived to be crucial in arthritis treatment, reinforcing the importance of the yoga environment and the yoga provider traits from previous qualitative research.[166,291,306,321] Another salient finding from our study highlighted yoga providers' concern that, with no existing regulations for yoga delivery in the UK, undertrained individuals can deliver yoga to people with or without any health condition. In addition, the variability in practices delivered as "yoga" might be contraindicated in specific health conditions, including arthritis, leading to yoga-related injuries. These perceived challenges underpin the need for effective regulation and accreditation of yoga delivery in the UK to ensure the credibility of yoga providers and the safety of the attendees, as highlighted previously by yoga providers.[322] Yoga

providers shared that some attendees with arthritis thought yoga was a physically challenging practice and were therefore reluctant to try yoga. Yoga providers added that unrealistic media portrayals of yoga might be a reason for their fear of practising yoga. This was supported by existing qualitative evidence suggesting that yoga was not generally represented as an adaptable and inclusive practice for varying needs and capabilities in the media, affecting its promotion and awareness among people.[323]

5.4.2 Implications for practice and future research

To maximise yoga's potential in arthritis treatment, there is a need to increase awareness of yoga and its benefits and promote its authentic representations to encourage people with arthritis to practice yoga. This could include initiatives to endorse yoga programmes for arthritis through partnerships between healthcare professionals, professional yoga organisations, and arthritis care organisations in the UK. Further, the provision of arthritis-specific yoga training programmes that are based on the best available scientific evidence is needed for yoga providers to meet the needs of attendees with arthritis adequately.[324] In addition, future research exploring qualitative insights from people with arthritis practising yoga will be helpful for triangulation with

our findings to get a deeper understanding of the use of yoga in arthritis treatment.

5.4.3 Strengths and limitations of the study

To my knowledge, this was the first study to explore clinical knowledge, experiences, and perceptions of UK-based yoga providers in arthritis treatment. The study specifically focused on yoga providers rather than healthcare professionals, as their experiential knowledge and perspectives differ from clinical expertise. While healthcare perspectives are valuable, yoga providers are key stakeholders in designing and delivering yoga interventions for people with arthritis, and no prior UK-based research has explored their insights. The inclusion of both yoga teachers and therapists enabled a diverse range of perspectives, enriching the understanding of current yoga delivery practices.

The use of in-depth semi-structured interviews allowed for a nuanced exploration of participants' experiences, allowing participants to share perspectives beyond the pre-determined questions. The interview guide, while informed by literature and expert discussion, may not have captured all areas of interest, particularly topics outside yoga providers' direct experience, such as detailed clinical management of arthritis. As a result, excluding healthcare professionals may limit the

transferability of the findings to other professional contexts. Our analysis of UK-based yoga providers' accounts reflects the potential transferability of these findings to similar contexts and healthcare settings.

Although all the interviews were conducted online, the lead researcher established rapport with each participant through an informal and friendly conversation before the interview and used positive non-verbal behaviours (e.g., eye contact, nodding) during the interview. However, conducting interviews online, although convenient, may have constrained the observation of non-verbal cues compared with face-to-face interviews. Qualitative research is largely dependent on the skills of the researchers, therefore making it challenging to maintain, assess, and demonstrate methodological rigour. Reflexivity was maintained throughout data collection and analysis, supported by a multidisciplinary research team with complementary expertise, which strengthened the credibility and depth of interpretation. The lead researcher had no prior acquaintance with participants and limited familiarity with yoga practice in the UK. The senior researchers brought extensive experience in evidence-based healthcare, including one with an educational background in Ayurveda and yoga from India, and reflexivity was maintained throughout data

collection and analysis to minimise bias and ensure balanced interpretation of findings.

Furthermore, selection bias may have been introduced as yoga providers with a strong interest or positive views on yoga's role in arthritis treatment may have volunteered to participate. Response bias could have also influenced the findings, with yoga providers possibly providing socially desirable responses, leading to an overrepresentation of positive insights. For instance, when asked about challenges in delivering yoga to attendees with arthritis, most yoga providers stated that no yoga-related injuries had occurred in their sessions, even though some injuries may have actually taken place.

This study primarily represented yoga teachers' views and since yoga in the UK is predominantly delivered by these professionals[148], their insights would be crucial in identifying and addressing the challenges in delivering yoga in arthritis treatment. Overall, while these limitations may affect the generalisability of the findings, the study's methodological transparency, reflexive practice, and triangulation within the research team support the credibility and transferability of the results.

5.5 Conclusion

Yoga providers felt they could play a key role in arthritis treatment in the UK, provided yoga is adequately promoted, made accessible to people with arthritis, yoga delivery is regulated, and yoga providers have access to arthritis specific yoga training using the best available scientific evidence. However, limited awareness of yoga's benefits among people with arthritis, inconsistent yoga provider training standards, and the lack of integration with healthcare services currently restrict its contribution to arthritis care. A collaborative effort between healthcare professionals, yoga organisations, and arthritis charities is needed to promote awareness, develop evidence-based yoga training, and facilitate safe and accessible yoga delivery.

Chapter Six: General discussion and conclusion

6.1 Brief overview of the thesis

The thesis contributes to a comprehensive understanding of yoga as a complementary approach to arthritis treatment in the UK healthcare context by critically examining the available evidence. It strengthens the evidence base for developing yoga interventions for osteoarthritis and rheumatoid arthritis, the two most common types in the UK. To inform feasibility and implementation, global evidence, including evidence from the UK, on the barriers and facilitators to yoga practice in people with arthritis, was synthesised in this research. The thesis also explores the current landscape and potential for yoga provision by gathering insights from UK-based yoga providers regarding arthritis treatment, which offered important insights into the feasibility of implementing yoga for arthritis treatment. This concluding chapter summarises the main findings from each chapter and discusses their implications for future evaluation and implementation efforts.

6.2 Summary of chapter findings

Chapters Two and Three synthesise the key features, namely content, structure, and delivery characteristics of effective yoga interventions used as a complementary approach, i.e., in addition to pharmacological, non-pharmacological treatment, or both, for osteoarthritis and conventional

medicine for rheumatoid arthritis, respectively. Yoga interventions for both conditions typically included three major components of yoga, i.e., yogic poses (asana), breathing practices (pranayama), and meditation (dhyana) and relaxation practices. Effective interventions included both centre-based and home-based sessions. Centre-based sessions offered supervision and group support, while home-based practice relied on resources such as written materials, yoga videos, and reminder calls and emails. The use of props such as blocks, straps, and chairs helped accommodate arthritis-specific needs. Findings suggest that a sustained yoga practice combining centre- and home-based sessions with appropriate modifications maximises benefits. Both chapters emphasise the need for robust, long-term RCTs with larger samples incorporating these key features. Chapter Four (a global systematic review of barriers and facilitators to yoga practice among people living with arthritis) and Chapter Five (qualitative interviews with UK-based yoga providers) reveal both shared and distinct insights. While both groups acknowledged the physical, mental, mind-body, and social benefits of yoga in arthritis treatment, they raised distinct concerns. Yoga providers highlighted the lack of regulation of yoga delivery and insufficient arthritis-specific yoga training based on the latest scientific evidence as major challenges. People with arthritis cited that logistical challenges and low

motivation discouraged yoga practice. Both groups noted that fear and hesitation, often due to limited awareness of yoga's benefits in arthritis, were common concerns for practising yoga. Yoga providers felt they had a vital role in supporting people with arthritis, emphasising the importance of empathy towards people with arthritis and their needs and arthritis-specific evidence-based training to enhance their ability to modify yoga safely. Similarly, people with arthritis also valued knowledgeable, empathetic, and professionally trained yoga providers who could modify yoga practices to meet their unique needs. Both yoga providers and people with arthritis recognised yoga as a holistic practice incorporating yogic poses, breathing practices, and meditation and relaxation practices, an interplay between which was perceived to enhance the mind-body connection. Both groups emphasised the need for group sessions to provide a safe, supportive, and judgment-free environment that fosters a sense of community and is led by empathetic, knowledgeable, and professionally trained yoga providers.

6.3 Comparing global evidence on synthesised effective yoga intervention features with yoga delivery for arthritis in the UK

There were notable similarities between the content, structure, and delivery characteristics of effective yoga interventions for

osteoarthritis and rheumatoid arthritis (Chapters Two and Three) and the way UK-based yoga sessions are conducted for attendees with arthritis (Chapter Five), as summarised in Table 25. However, a direct comparison was challenging, as none of the included studies in the systematic reviews (Chapters Two and Three) were based in the UK. Effective interventions consistently incorporated the three major components of yoga, including yogic poses, breathing practices, and meditation and relaxation practices. Similarly, Chapters Four and Five highlighted how these components collectively contribute to holistic well-being for people with arthritis. Therefore, including these three major components in yoga interventions is essential to maximise yoga's potential as a holistic complementary approach to arthritis treatment. UK-based yoga providers mentioned delivering gentler yoga styles, such as Hatha yoga, which involve holding poses longer and are considered more suitable for people with arthritis, as compared to physically demanding styles such as Vinyasa yoga. Notably, most effective interventions in the systematic reviews did not report the yoga style used, except for three, which included Hatha yoga. Specifically, yogic poses such as yogic poses such as Virabhadrasana (warrior pose), breathing practices such as Nadishuddhi pranayama (alternate nostril breathing) and meditation and relaxation practices, including Savasana

(corpse pose), were used in both global interventions (Chapters Two and Three) and UK-based sessions (Chapter Five). Across both global evidence and UK practice, the emphasis was on "gentle" movements and the use of props (e.g., chairs, blocks, bolsters, blankets) to ensure safety and enhance accessibility to yoga for people with arthritis. For example, yoga providers in the UK often mentioned modifying yogic poses such as Virabhadrasana using chairs or walls or avoiding it altogether due to concerns about stress on the knee joints. Some also reported modifying the downward-facing dog pose (Adho mukha svanasana) by asking the attendees to place their forearms on blocks instead of pressing through the hands, to reduce pressure on the wrists and provide a more accessible version of the pose for those with arthritis. Similarly, for meditation and relaxation practices, attendees were advised to lie on their side, front, or whichever position felt most comfortable. A notable distinction in modification approaches emerged between UK-based yoga therapists and yoga teachers. Yoga therapists tended to customise yoga sessions based on individual goals and needs, while yoga teachers preferred an inclusive, risk-averse, group-friendly approach that meets arthritis-specific needs while maintaining inclusivity in group sessions. Despite different preferred approaches, both prioritised the capability, comfort, and safety of attendees. Effective interventions

combined supervised, centre-based sessions with recommended home-based practice, and this format was also followed in yoga sessions in the UK. However, UK-based yoga providers noted that home practice might be challenging for attendees due to low motivation and a lack of access to equipment and resources. They also mentioned that many of their attendees preferred centre-based sessions that offered professional supervision and peer support. Effective interventions typically lasted between 50 and 70 minutes per session (Chapters Two and Three), comparable to UK sessions, where group sessions lasted about one hour (Chapter Five). This comparison highlights both the areas of alignment and the gaps between what the global evidence suggests for effective yoga interventions and what is currently delivered by yoga providers in the UK, particularly for arthritis treatment. UK-based yoga providers offered valuable insights into what they found acceptable in practice, drawing on their day-to-day experience. However, these accounts were based on practical experiences, limited by the absence of input from other key stakeholders, such as rheumatologists and other healthcare professionals. These findings underscore the need for more context-specific research exploring how yoga can fit within the existing UK healthcare system. The following section discusses future directions for research and practice.

Table 25 Comparison of global evidence on synthesised effective yoga intervention features (chapters two and three) with yoga delivery for arthritis in the UK (chapter five).

Feature	Effective yoga interventions conducted globally for osteoarthritis and rheumatoid arthritis treatment (chapters two and three)	Yoga sessions in the UK, focused on delivering yoga to people with arthritis (chapter five)
Major components	Asana, pranayama, and dhyana and relaxation practices	Asana (emphasis on gentle movements), pranayama, and dhyana and relaxation practices
Common practices	Yogic poses: Trikonasana Virabhadrasana Breathing practices: Nadishuddhi pranayama Kapalabhati Meditation and relaxation practices: Savasana	Yogic poses: Trikonasana Virabhadrasana Breathing practices: Nadishuddhi pranayama Kapalabhati Meditation and relaxation practices: Savasana
Session structure	Centre: Eight weeks (53–68 min) Home: 10 weeks (30-40 min)	Centre: approximately one hour Home-based practice encouraged, duration not specified
Modifications based on arthritis-specific needs	Common in osteoarthritis and rheumatoid arthritis (e.g., chair) Four osteoarthritis-related studies and two rheumatoid arthritis-related studies used specific modifications	Central to practice, props for confidence and support Yoga therapists - Customised to individual goals Yoga teachers - risk-averse approach ensuring safety and inclusion
Supervision	Certified, experienced, or trained yoga providers, but no elaborate description on yoga provider qualifications and training regarding intervention protocol	Yoga providers (teachers and therapists) associated with professional yoga organisations
Monitoring and adherence strategies	Self-recorded diaries, videos, reminder calls/emails	Feedback from attendees

6.4 Directions for future practice and research

The findings from chapters two and three of this thesis, also published as peer-reviewed manuscripts[278,279], align with existing effectiveness systematic reviews on osteoarthritis and rheumatoid arthritis, suggesting that yoga may relieve joint pain and inflammation, reduce disease activity scores (in rheumatoid arthritis) and improve function.[176,181] Yoga's slow and controlled stretches may help alleviate pain, stiffness and muscle tension, while its breathing practices, and meditation and relaxation practices can release stress, calm the mind, and regulate inflammation through increased parasympathetic activity.[155,157,159] As highlighted in findings from chapters four and five, it is important to consider yoga as a holistic approach, i.e., in its entirety, by including its major components, namely asana (yogic poses), pranayama (breathing practices), and dhyana (meditation) and relaxation practices to support arthritis treatment. This holistic approach can be particularly beneficial to address sleep and fatigue issues, commonly experienced in arthritis, while also encouraging an active lifestyle.[298,325]

Ensuring these components are consistently included may also help counter narrow Western media portrayals of yoga that often emphasise physical postures, neglecting other essential components.[323] These depictions can limit the

perceived accessibility of yoga as a safe and holistic practice to those who may be unaware of yoga's benefits or to people who could experience health benefits but feel excluded from yoga practice. Further, findings from chapters four and five noted yoga's adaptability as a key advantage to meet the ever-changing needs of people with arthritis based on their symptoms, which could be especially beneficial for older adults.[326] Chapters Four and Five findings also emphasised that group-based sessions in a safe and inclusive environment, delivered and supervised by empathetic and well-trained yoga providers, are crucial for facilitating yoga practice in people with arthritis. Practising yoga in groups, with a supportive, caring, and knowledgeable yoga provider, is an important practical consideration to enhance social connections and inclusion[166], which is particularly important for people with arthritis who may generally feel isolated.

These insights can also be linked to the patient journey described in Chapter One, where people with arthritis may often face challenges in self-management, including maintaining regular physical activity, coping with symptoms, and sustaining motivation. The barriers identified in Chapter Four, such as logistical difficulties, low levels of motivation, and limited awareness of yoga's benefits, can disrupt this journey towards yoga practice. Adaptable, supportive yoga

interventions delivered in group-based or home-based formats may help overcome these barriers and enhance engagement with holistic self-management through yoga practice in arthritis.

Given the growing global popularity of complementary treatments for musculoskeletal conditions, including arthritis, it is timely to expand the evidence base on yoga for arthritis.[247] Despite promising findings, the current evidence for yoga's effectiveness in arthritis treatment is limited in both quality and quantity, indicating the need for increased research attention and funding in this area.[247] Findings from chapters two and three of this thesis offer insights into the key features of effective yoga interventions for osteoarthritis and rheumatoid arthritis, which can serve as a foundation for developing evidence-based interventions tailored to these conditions. An important next step is to evaluate whether these yoga interventions, incorporating the key features synthesised in Chapters Two and Three, are indeed effective. For this, a Delphi study should first be undertaken to reach expert consensus on the synthesised key features of yoga interventions for osteoarthritis and rheumatoid arthritis treatment, informing the development of a comprehensive intervention manual for yoga providers. Following this, pilot studies should be conducted to assess the feasibility of

delivering yoga interventions for both conditions. Qualitative methods such as surveys or interviews could be used to explore patient and yoga provider experiences and the acceptability of these interventions among key stakeholders. These include arthritis patients and healthcare professionals such as rheumatologists, orthopaedic surgeons, nurses, GPs, yoga experts, and yoga providers. Finally, rigorously designed RCTs are required to evaluate both the clinical and cost-effectiveness of these yoga interventions, with careful consideration of what is delivered as the control intervention. If found to be effective and safe, yoga could be implemented as a complementary approach to arthritis treatment in the UK and other countries. However, successful implementation also depends on addressing the real-world factors discussed in Chapter four that may hinder or encourage yoga practice among people with arthritis. Building upon these insights, the following section explores how yoga can be a beneficial addition to arthritis treatment within the UK's healthcare landscape.

Although this thesis focused on osteoarthritis and rheumatoid arthritis, many of the mechanisms through which yoga may confer benefit, such as reductions in pain perception, improved joint movement, and enhanced mental health outcomes, may also be relevant to other types of arthritis.

Therefore, future research could explore whether the key features of effective interventions synthesised here, such as combining physical postures, breathing practices, and meditation and relaxation practices, are similarly effective and acceptable in these conditions. Comparative studies across different rheumatic diseases may help identify shared and arthritis-specific adaptations of yoga interventions.

6.5 Potential role of yoga as a complementary approach to arthritis treatment in the UK

6.5.1 Healthcare professionals and patient organisations

This thesis underscores several factors supporting yoga's considerable potential as a complementary approach to arthritis treatment in the UK. Chapters Four and Five, the latter published as a peer-reviewed article[307], consistently highlight both patients' and yoga providers' perceptions of yoga's holistic aspect, which not only addresses the physical symptoms but also caters to the mental health needs in arthritis. The findings also suggest that group-based sessions further enhance social connections, alleviating feelings of isolation commonly experienced by people with arthritis. These aspects, combined with the willingness of UK-based yoga providers to adapt practices and foster safe and

supportive spaces, strengthen yoga's role as a promising addition to arthritis treatment in the UK.

Although osteoarthritis and rheumatoid arthritis differ in underlying pathology, the findings of this thesis indicate commonality in how yoga is practised across both conditions. Core components such as gentle movement, breathing practices, and meditation and relaxation practices appear relevant to people with either condition, as both groups experience pain, reduced mobility, and limitations in daily activities. The primary differences lie not in the overall aims of yoga but in the adaptations required, such as modifications to accommodate joint pain or inflammation associated with flares in rheumatoid arthritis. These shared needs suggest that the yoga components identified in Chapters Two and Three may be broadly transferable, with condition-specific tailoring achieved through appropriate adaptations and pacing rather than fundamentally different practices. This highlights yoga's versatility as a complementary approach within wider rheumatology care.

Yoga providers felt they could play a key role in arthritis treatment in the UK, provided yoga is adequately promoted and made accessible to people with arthritis, yoga delivery is regulated, and yoga providers have access to arthritis-specific

yoga training using the best available scientific evidence. However, limited awareness of yoga's benefits in arthritis among people with arthritis, unregulated yoga provider training standards, and the lack of integration with healthcare services currently limit its contribution to arthritis care. Collaboration between healthcare professionals, yoga organisations, and arthritis charities is needed to promote awareness, develop evidence-based training, and facilitate safe and accessible yoga delivery for arthritis care.

The National Rheumatoid Arthritis Society (NRAS) has developed resources to support people with rheumatoid arthritis in engaging with physical activity, including yoga, as a complementary approach to symptom management.[327] NRAS's SMILE-RA programme includes modules on chair yoga exercises, delivered by experts and adapted for people with rheumatoid arthritis, with options for seated or standing practice to accommodate varying levels of mobility.[327] These resources aim to provide safe, accessible, and evidence-informed guidance, addressing both the physical and psychosocial benefits of yoga while supporting self-management and functional improvement in people living with rheumatoid arthritis.[327]

Arthritis UK (previously Versus Arthritis) acknowledges the benefits of yoga for individuals with arthritis, highlighting its role in improving strength, flexibility, and fitness, while also contributing positively to mental health.[328] The organisation emphasises the importance of incorporating a mixture of exercises, including yoga, to manage arthritis symptoms effectively.[328] Through campaigns like "Let's Move with Leon," Arthritis UK provides accessible exercise programs, including yoga, to encourage physical activity among individuals with arthritis.[329] These programs are designed to be inclusive, offering seated and standing options to cater to diverse needs. In summary, these patient organisations are committed to promoting yoga as a beneficial practice for individuals with rheumatoid arthritis, offering resources, community programs, and educational materials to support its integration into arthritis care.

Moving forward, deeper engagement with healthcare professionals and patient organisations will be crucial to co-develop clear referral pathways, improve public awareness, and ensure that evidence-based, arthritis-specific yoga is accessible and integrated into routine care.

6.5.2 Community-based initiatives

Tailored approaches that consider barriers to participation, such as culturally sensitive yoga programme design and inclusive messaging, including consideration of gender-related perceptions of yoga, may be beneficial and help improve accessibility and uptake across diverse populations in the UK. For instance, men-only yoga classes could be explored as a way to address gender disparities and encourage participation among men with arthritis, particularly if aligned with their identified needs and relevant barriers to yoga practice.[235,330]

Additionally, the acceptability of yoga may vary across different ethnic and cultural groups.[182] Perceptions of yoga, prior experience, and cultural beliefs about exercise and complementary approaches can influence engagement. Some groups may be less familiar with yoga or perceive it as less relevant, whereas others may be more receptive due to alignment with holistic mind-body practices.[331] Tailored outreach, culturally sensitive programme design, and inclusive messaging can help address these barriers. To enhance future uptake, community-based initiatives should test and refine these tailored strategies to determine which approaches most effectively reduce participation barriers for diverse groups.

6.5.3 Cultural, demographic, and equity considerations

Access to yoga may be influenced by socioeconomic, geographic, and other social determinants of health.[332] People from lower-income backgrounds, those living in rural areas, or those with mobility or disability limitations may face greater barriers to attending yoga sessions. To promote equitable access, yoga interventions should consider affordability, transport, accessibility of venues, and flexible delivery modes (e.g., online or community-based sessions). Addressing these inequalities is essential to ensure that the benefits of yoga are available to all people with arthritis. Future efforts should therefore focus on developing and evaluating equitable yoga programmes capable of reaching underserved populations and reducing disparities in access.

6.5.4 Policy-driven efforts

Expanding access to yoga through workplace wellness programmes and community settings aligns with the priorities of the NHS in their Long Term Plan and NICE guidelines for osteoarthritis, which emphasise community-based interventions and equitable access to physical activity for chronic conditions, including arthritis.[333,52] Such initiatives can help reduce health inequalities by reaching people with arthritis irrespective of their socioeconomic backgrounds. By adopting these diverse, evidence-informed strategies, yoga

has the potential to become a valuable complementary approach to arthritis treatment within the UK's healthcare system.

Social prescribing, where GPs and primary care professionals refer patients to community-based programs, could be a promising approach to the integration of yoga into the healthcare system in the UK.[334] Building on initiatives like the Yoga4Health programme within the NHS, which utilises social prescribing to promote yoga as part of holistic health treatment, can serve as a practical model to support the integration of yoga for arthritis treatment in the UK.[335,336] Policymakers can play a crucial role by supporting research into the clinical effectiveness, cost-effectiveness, and safety of yoga for arthritis treatment. They can facilitate the development of evidence-based clinical guidelines, promote professional yoga training for yoga providers, and ensure access to yoga in diverse healthcare settings. Further, encouraging the inclusion of yoga in medical school curricula can also enable healthcare professionals to make informed recommendations to people with arthritis.[337] Looking ahead, policymakers will need to support sustained investment in research, training, and social prescribing pathways so that yoga can be implemented safely and widely across UK healthcare settings.

Misinformed media portrayals may further hinder accessibility to yoga, and so countering misconceptions about yoga is also essential.[323] Awareness initiatives should promote accurate and inclusive representations of yoga, emphasising its accessibility, adaptability, and holistic nature. Collaborations between professional yoga associations and arthritis care organisations in the UK can help drive these efforts.

6.5.5 Insights from an international model

A successful integration of yoga in clinical practice is the model developed at the National Institute of Mental Health and Neurosciences (NIMHANS) in India, where yoga was first integrated within the psychiatry department and later expanded into a formal clinical service.[338] Key aspects of this model include physician referrals, medical screening of patients, yoga modules tailored to specific conditions, and delivery by trained yoga therapists.[338]

As arthritis affects both physical and mental well-being over time, incorporating yoga as a holistic approach in a structured manner, drawing from this model, may offer potential benefits. However, its direct application to arthritis treatment in the UK requires high-quality RCTs to establish

effectiveness, along with careful consideration of demographic differences in people with arthritis, cultural perceptions of yoga, and healthcare infrastructure. Adapting such a model for the UK will require systematic piloting, including context-specific evaluation of safety, feasibility, and acceptability, to identify components that are appropriate, feasible, and effective within UK rheumatology care.

6.5.6 Research and evidence gaps

This thesis has several strengths, including the comprehensive synthesis of global evidence, integration of qualitative insights from UK-based yoga providers, and a holistic focus on yoga's physical, mental, and social benefits. Limitations include the predominance of non-UK studies, small sample sizes in some RCTs (Chapters Two and Three), variable intervention durations, and no input from healthcare professionals and underrepresented populations, which were beyond the scope of this thesis.

These considerations inform recommendations for future research and practice: UK-specific pilot studies, high-quality RCTs, as well as qualitative and mixed-methods studies are essential to validate the effectiveness, feasibility, and acceptability of yoga interventions. The lack of regulatory standards for yoga delivery raises concerns around the safety

of people practising yoga and the credibility of yoga providers. The Complementary and Natural Healthcare Council (CNHC), which is a voluntary regulatory body of complementary healthcare practitioners in the UK, has also recognised this gap and the need for standardised training to ensure the safety of attendees.[147] Additionally, Chapter Five sheds light on the lack of specialised training for yoga providers, underscoring the need for evidence-based, arthritis-specific training.[307] This would equip yoga providers to meet the individual needs of people with arthritis across various community and healthcare settings, through a consistent approach. Addressing these gaps through high-quality research and the development of standardised, evidence-informed, contextually relevant training provisions will be essential to ensure that yoga is implemented safely, credibly, and sustainably as a complementary approach to arthritis treatment within the UK healthcare system.

6.6 Conclusion

This thesis strengthens evidence on yoga's potential as a complementary approach to arthritis treatment in the UK. It provides valuable data that can be utilised for the development of tailored yoga interventions, particularly for the two most prevalent types, i.e., osteoarthritis and rheumatoid arthritis. Effective interventions for both

conditions shared some consistent key features, such as the inclusion of yogic poses, breathing practices, and meditation and relaxation practices, delivered over a sustained period through both group-based sessions and individual home practice. To advance implementation, these synthesised features should be used to guide intervention development, followed by validation, refinement, and feasibility testing through pilot studies. Subsequently, high-quality, long-term RCTs will be essential to evaluate the effectiveness of these interventions. This thesis underscores yoga's holistic and adaptable nature while acknowledging the key challenges that must be addressed to enable real-world implementation, particularly in the UK context. While yoga providers in the UK have shown willingness to support people with arthritis, successful implementation will require efforts to improve public awareness and promotion of yoga for arthritis, regulate yoga delivery, and provide arthritis-specific, evidence-based training for yoga providers in the UK. Overall, this work contributes to a deeper understanding of yoga's complementary role in arthritis treatment and offers a foundation for future research, clinical practice, and potential integration of yoga into the UK healthcare system. While the evidence in this thesis centred on osteoarthritis and rheumatoid arthritis, yoga's holistic mind-body approach and its adaptability are relevant to other types of arthritis. Future

work could extend these findings to develop and evaluate yoga-based interventions tailored to the broader spectrum of rheumatic diseases, thereby enhancing the inclusivity and impact of complementary approaches within rheumatology.

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Appendices

Appendix 1: Search strategies (Chapter Two)

MEDLINE (Ovid) <1946 to 22 September 2023>:

210 records

1. exp Mind-Body Therapies/
2. mind body therap*.mp.
3. meditat*.mp.
4. (yoga* or yogi*).mp.
5. (Asana* or pranayam* or dhyan* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda).mp.
6. 1 or 2 or 3 or 4 or 5
7. exp Osteoarthritis/
8. (osteoarthr* or osteo-arthr*).mp.
9. Coxarthrosis.mp.
10. Arthrosis deformans.mp.
11. (Degenerative adj2 arthritis).mp.
12. Degenerative joint disease*.mp.
13. Non-inflammatory arthritis.mp.
14. 7 or 8 or 9 or 10 or 11 or 12 or 13

15. randomized controlled trial.pt.
16. controlled clinical trial.pt.
17. randomized.ab.
18. placebo.ab.
19. drug therapy.fs.
20. randomly.ab.
21. trial.ab.
22. groups.ab.
23. 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22
24. exp animals/ not humans.sh.
25. 23 not 24
26. 6 and 14 and 25

EMBASE (Ovid) <1974 to 22 September 2023>:

550 records

1	exp alternative medicine/
2	exp yoga/
3	exp meditation/
4	Mind body therap*.mp.
5	(Yoga* or yogi*).mp.
6	Meditat*.mp.
7	(Asana* or pranayam* or dhyan* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or

mudra* or chanda or sivananda).mp.

8 1 or 2 or 3 or 4 or 5 or 6 or 7

9 exp osteoarthritis/

10 (osteoarthr* or osteo-arthr*).mp.

11 Coxarthrosis.mp.

12 Arthrosis deformans.mp.

13 (Degenerative adj2 arthritis).mp.

14 Degenerative joint disease*.mp.

15 Non-inflammatory arthritis.mp.

16 9 or 10 or 11 or 12 or 13 or 14 or 15

17 Randomized controlled trial/

18 Controlled clinical trial/

19 random*.ti,ab.

20 randomization/

21 intermethod comparison/

22 placebo.ti,ab.

23 (compare or compared or comparison).ti.

24 ((evaluated or evaluate or evaluating or assessed or assess) and (compare or compared or comparing or comparison)).ab.

25 (open adj label).ti,ab.

26 ((double or single or doubly or singly) adj (blind or blinded or blindly)).ti,ab.

27 double blind procedure/

28 parallel group*1.ti,ab.

29 (crossover or cross over).ti,ab.

30 ((assign* or match or matched or allocation) adj5 (alternate or group*1 or intervention*1 or patient*1 or subject*1 or participant*1)).ti,ab.

31 (assigned or allocated).ti,ab.

32 (controlled adj7 (study or design or trial)).ti,ab.

33 (volunteer or volunteers).ti,ab.

34 human experiment/

35 trial.ti.

36 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35.

37 (random* adj sampl* adj7 (cross section* or questionnaire*1 or survey* or database*1)).ti,ab. not (comparative study/ or controlled study/ or randomi?ed controlled.ti,ab. or randomly assigned.ti,ab.)

38 Cross-sectional study/ not (randomized controlled trial/ or controlled clinical study/ or controlled study/ or randomi?ed controlled.ti,ab. or control group*1.ti,ab.)

39 (((case adj control*) and random*) not randomi?ed controlled).ti,ab.

40 (Systematic review not (trial or study)).ti.

41 (nonrandom* not random*).ti,ab.

42 Random field*.ti,ab.

43 (random cluster adj3 sampl*).ti,ab.

44 (review.ab. and review.pt.) not trial.ti.

45 we searched.ab. and (review.ti. or review.pt.)

46 update review.ab.

47 (databases adj4 searched).ab.

48 (rat or rats or mouse or mice or swine or porcine or murine or sheep or lambs or pigs or piglets or rabbit or rabbits or cat or cats or dog or dogs or cattle or bovine or monkey or monkeys or trout or marmoset$1).ti. and animal experiment/

49 Animal experiment/ not (human experiment/ or human/)

50 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49

51 36 not 50

52 8 and 16 and 51

PsycInfo (OVID) <1806 to 22 September 2023>: 14 records

1 exp Mind Body Therapy/

2 Mind-body therap*.mp.

3 exp Yoga/

4 (Yoga* or yogi*).mp.

5 exp Meditation/

6 Meditat*.mp.

7 (Asana* or pranayam* or dhyan* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or

mudra* or chanda or sivananda).mp.

8 1 or 2 or 3 or 4 or 5 or 6 or 7

9 (Osteoarthr* or osteo-arthr*).mp.

10 Coxarthrosis.mp.

11 Arthrosis deformans.mp.

12 (Degenerative adj2 arthritis).mp.

13 Degenerative joint disease.mp.

14 Non-inflammatory arthritis.mp.

15 9 or 10 or 11 or 12 or 13 or 14

16 (Randomized Controlled Trial or Controlled Clinical Trial or Pragmatic Clinical Trial or Equivalence Trial or Clinical Trial, Phase III).pt.Randomized Controlled Trial/

17 exp Randomized Controlled Trials/

18 “Randomized Controlled Trial.mp

19 Controlled Clinical Trial/

20 Controlled Clinical Trials/

21 exp Clinical Trials/

22 “Controlled Clinical Trial.mp

23 Randomization/

24 Random Allocation/

25 Double-Blind Method/

26 Double Blind Procedure/

27 Double-Blind Studies/

28 Single-Blind Method/

29 Single Blind Procedure/

30 Single-Blind Studies/

31 Placebos/

32 Placebo/

33 Control Groups/

34 Control Group/

35 (random* or sham or placebo*).ti,ab,hw.

36 ((singl* or doubl*) adj (blind* or dumm* or mask*)).ti,ab,hw.

37 ((tripl* or trebl*) adj (blind* or dumm* or mask*)).ti,ab,hw.

38 (control* adj3 (study or studies or trial* or group*)).ti,ab.

39 (Nonrandom* or non random* or non-random* or quasi- random* or quasirandom*).ti,ab,hw.

40 allocated.ti,ab,hw.

41 ((open label or open-label) adj5 (study or studies or trial*)).ti,ab,hw.

42 ((equivalence or superiority or non-inferiority or noninferiority) adj3 (study or studies or trial*)).ti,ab,hw.

43 (pragmatic study or pragmatic studies).ti,ab,hw.

44 ((pragmatic or practical) adj3 trial*).ti,ab,hw.

45 ((quasiexperimental or quasi-experimental) adj3 (study or studies or trial*)).ti,ab,hw.

46 (phase adj3 III adj3 (study or studies or trial*)).ti,hw.

47 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47

48 8 and 15 and 47

CINAHL (EBSCOHost) <1994 to 22 September 2023>: 539 records

S1 (MH “Yoga”)

S2 (MH “Mind Body Techniques+”)

S3 (MH “Meditation”)

S4 TX Yoga* or yogi*

S5 TX “Mind body therap*”

S6 TX Meditat*

S7 TX pranayam* or dhyan* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda

S8 S1 or S2 or S3 or S5 or S6 or S7

S9 MH Osteoarthritis

S10 TX Osteoarthr* or Osteo-arthr*

S11 TX Arthrosis deformans

S12 TX Coxarthrosis

S13 TX Degenerative adj2 arthritis

S14 TX Degenerative arthritis

S15 TX Degenerative joint disease*

S16 TX Non-inflammatory arthritis

S17 S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16

S18 (MH “Randomized Controlled Trials”)

S19 (MH “Double-Blind Studies”)

S20 (MH “Single-Blind Studies”)

S21 (MH “Random Assignment”)

S22 (MH “Pretest-Posttest Design”)

S23 (MH “Cluster Sample”)

S24 TI (randomised or randomized)

S25 AB (random*)

S26 TI (trial)

S27 TI (sample size) and AB (assigned OR allocated OR control)

S28 MH placebos

S29 PT randomized controlled trial

S30 AB control W5 group

S31 AB (crossover design) or MH (comparative studies)

S32 AB cluster W3 RCT

S33 MH animals+

S34 MH animal studies

S35 TI animal model*

S36 S33 or S34 or S35

S37 MH human

S38 S36 not S37

S39 S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32

S40 S39 not S38

S41 S8 and S17 and S40

Cochrane Central Register of Controlled Trials (CENTRAL) <1996 to 22 September 2023>: 266 records

#1 MeSH descriptor: [Mind-Body Therapies] explode all trees

#2 MeSH descriptor: [Meditation] explode all trees

#3 (yoga*) (Word variations have been searched)

#4 (Mind body therapies) (Word variations have been searched)

#5 (yogi*) (Word variations have been searched)

#6 (asana* or pranayam* or dhyan* or meditat* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda) (Word variations have been searched)

#7 #1 or #2 or #3 or #4 or #5 or #6

#8 MeSH descriptor: [Osteoarthritis] explode all trees

#9 (osteoarthr*) (Word variations have been searched)

#10 MeSH descriptor: [Osteoarthritis, Hip]

#11 MeSH descriptor: [Osteoarthritis,Knee]

#12 MeSH descriptor: [Osteoarthritis, Spine]

#13 (“arthrosis deformans”) (Word variations have been searched)

#14 Degenerative adj2 arthritis

#15 (“degenerative joint disease”) (Word variations have been searched)

#16 (“degenerative arthritis”) (Word variations have been searched)

#17 (non-inflammatory arthritis) (Word variations have been searched)

#18 #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17

#19 MeSH descriptor: [Randomized Controlled Trial] explode all trees

#20 MeSH descriptor: [Controlled Clinical Trial] explode all trees

#21 placebo*

#22 (“randomised clinical trial”) (Word variations have been searched)

#23 (trial*) (Word variations have been searched)

#24 MeSH descriptor: [Randomized Controlled Trials as Topic] explode all trees

#25 #19 or #20 or #21 or #22 or #23 or #24

#26 #7 and #18 and #25

Allied and Complementary Medicine (AMED) (Ovid) <1985 to 22 September 2023>: 13 records

1. exp Mind body medicine/

2. exp Yoga/

3. exp Meditation/

4. Mind body medicine*.mp.

5. (Yoga* or yogi*).mp.

6. Meditat*.mp.

7. (Asana* pranayam* or dhyan* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda).mp.

8. 1 or 2 or 3 or 4 or 5 or 6 or 7

9. exp Osteoarthritis/

10. (osteoarthr* or osteo-arthr*).mp.

11. Coxarthrosis.mp.

12. Arthrosis deformans.mp.

13. (Degenerative adj2 arthritis).mp.

14. Degenerative joint disease*.mp.

15. Non-inflammatory arthritis.mp.

16. 9 or 10 or 11 or 12 or 13 or 14 or 15

17. (random* or factorial* or placebo* or assign* or allocat* or crossover*).tw.

18. (cross adj over*).tw.

19. (trial* and (control* or comparative)).tw.

20. ((blind* or mask*) and (single or double or triple or treble)).tw.

21. (treatment adj arm*).tw.(control* adj group*).tw.

22. (phase adj (III or three)).tw.

23. (versus or vs).tw.

24. rct.tw.

25. RANDOM ALLOCATION/

26. DOUBLE BLIND METHOD/

27. placebos/

28. randomized controlled trials/

29. 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28

30. 8 and 16 and 29

SPORTDiscus (EBSCOHost) <2004 to 22 September 2023>: 15 records

S1 SU Mind body therapy

S2 SU Yoga

S3 SU Meditation

S4 TX Mind body therap*

S5 TX Yoga* or yogi*

S6 TX Meditat*

S7 TX Asana* pranayam* or dhyan* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja

or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda

S8 S1 or S2 or S3 or S4 or S5 or S6 or S7

S9 SU Osteoarthritis

S10 TX Osteoarthr* or osteo-arthr*

S11 TX Coxarthrosis

S12 TX Arthrosis deformans

S13 TX degenerative arthritis

S14 TX degenerative joint disease*

S15 TX Non-inflammatory arthritis

S16 S9 or S10 or S11 or S12 or S13 or S14 or S15

S17 SU Randomized controlled trials

S18 TX Randomized controlled trials

S19 TX Double-blind studies

S20 TX Single-blind studies

S21 TX Random assignment

S22 TX Pretest-posttest design

S23 TX Cluster sample

S24 TX Placebos

S25 TX randomised or randomized

S26 TX random*

S27 TX trial*

S28 S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27

S29 S8 and S16 and S28

Web of Science <1998 to 22 September 2023>: 142 records

#1 ALL= (yoga* or “mind body therap*” or meditation or yogi* or asana* or pranayam* or dhyan* or meditat* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda)

#2 ALL= (“Osteoarthritis” or osteoarthr* or osteo-arthr* or “coxarthrosis” or degenerative arthritis or degenerative joint disease* or non-inflammatory arthritis)

#3 ALL= (“randomized controlled trial” or “controlled clinical trial” or “clinical trial” or “clinical trials” or placebo$ or “random allocation” or “double-blind method” or “single-blind method” or “cross-over studies”)

#4 ALL= (randomised or randomized or randomisation or randomisation or placebo* or (random* and (allocat* or assign*)) or (blind* and (single or double or treble or triple)))

#5 #3 or #4

#6 #1 and #2 and #5

Turning Research Into Practice (TRIP) <2014 to 22 September 2023>: 3130 records

yoga* OR "mind body therapies" OR yogi* OR asana* OR pranayam* OR dhyan* OR meditation OR meditate OR ashtanga OR bikram OR hatha OR iyengar OR kripalu OR kundalini OR vinyasa OR raja OR radja OR bhakti OR jnana OR kriya* OR karma OR yama OR niyama OR pratyahara OR dharana OR samadhi OR bandha OR mudra* OR chanda OR sivananda AND ("osteoarthritis" OR osteoarthr* OR osteo- arthr* OR coxarthrosis OR degenerative arthritis OR degenerative joint disease* OR non-inflammatory arthritis) AND (randomised controlled trial OR randomized controlled trial OR controlled clinical trial* OR clinical trial* OR placebo* OR random*)

AYUSH Research Portal (Ministry of AYUSH, Government of India): 33 records

Medical system: yoga and naturopathy

Category: preclinical research, clinical research (Evidence grade - A, B, C) and fundamental research

Body system: musculoskeletal

Disease (English): Osteoarthrosis of hip (ICPC-L89) (ICD-M16)

Evidence grade- A:1 Evidence grade-B:0 Evidence grade-C:0 Disease (English): osteoarthrosis of knee (ICPC-L90) (ICD-M17) Evidence grade-A:6 Evidence grade-B:23 Evidence grade-C:0

Disease (English): osteoarthrosis other (ICPC-L91) (ICD-M13, M15, M18, M19)

Evidence grade-A:1 Evidence grade-B:2 Evidence grade-C:0

A Bibliography of Indian Medicine (ABIM): 1 record

Search terms used: yoga and osteoarthritis

Complementary and alternative medicine (CAM-QUEST): 61 records

Searched for the following:

Disease pattern: pain (1155 results) to disease: chronic pain (209 results) to therapy: mind body medicine (75 results) to study design: randomized trial (33 results)

Searched for the following:

Therapy: Mind-body medicine (3708 results) to disease pattern: Musculoskeletal-/Connective tissue system (388 results) to disease: Arthritis (24 results) to study design: Randomized trial (13 results)

Therapy: Mind-body medicine (3708 results) to disease pattern: Musculoskeletal-/Connective tissue system (388 results) to disease: Arthrosis (37 results) to study design: Randomized trial (15 results)

Physiotherapy Evidence Database (PeDro) <1999 to 22 September 2023>: 39 records

Searched terms used: yoga and osteoarthritis

OpenGrey (Data Archiving and Network Services) <1997 to 22 September 2023>: 0 records

Search terms used: yoga and osteoarthritis

EthOS <2009 to 22 September 2023>: 623 records

Mind-Body Therapies or mind body therap*.mp. or meditat* or yoga* or yogi* or asana* or pranayam* or dhyan* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or

kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda or osteoarthritis or degenerative joint disease or randomized controlled trial

ProQuest Dissertations and Theses <1902 to 22 September 2023>:1051 records

(yoga* or mind body therap* or yogi* or asana* or pranayam* or dhyan* or meditat* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda) and (osteoarthritis or osteoarthr* or osteo-arthr* or coxarthrosis or degenerative adj2 arthritis or degenerative joint disease* or non-inflammatory arthritis) and (randomised controlled trial or randomized controlled trial or controlled clinical trial* or clinical trial* or placebo* or random* or trial*)

DART-Europe-e-theses portal <2005 to 22 September 2023>: 6 records

Yoga or asana* or pranayam* or dhyan* or osteoarthritis or degenerative joint disease or non-inflammatory arthritis or RCT or randomized controlled trial

Appendix 2: Excluded studies with reasons for exclusion (Chapter Two)

Full-text studies excluded (n=25)

Related to comparator (n=1)

Buchanan DT, Vitiello MV, Bennett K. Feasibility and efficacy of a shared yoga intervention for sleep disturbance in older adults with osteoarthritis. J Gerontol Nurs. 2017. doi: 10.3928/00989134- 20170405-01.

Related to outcome (n=7)

McCaffrey R, Park K, Newman D. Chair yoga: feasibility and sustainability study with older community-dwelling adults with osteoarthritis. Holist Nurs Pract. 2017;31(3):148-57.

Moonaz SH, Bingham CO, Wissow L, Bartlett SJ. Yoga in sedentary adults with arthritis: effects of a randomized controlled pragmatic trial. J Rheumatol. 2015;42(7):1194-1202.

Middleton KR, Ward MM, Moonaz SH, Lopez MM, Tataw-Ayuketah G, Yang L, et al. Feasibility and assessment of

outcome measures for yoga as self-care for minorities with arthritis: a pilot study. Pilot Feasibility Stud. 2018;4. doi:10.1186/s40814-018-0248-x.

Middleton KR, Ward MM, Haaz S, Velummylum S, Fike A, Acevedo AT, et al. A pilot study of yoga as self-care for arthritis in minority communities. HQLO. 2013;11:55. doi: 10.1186/1477-7525-11-55.

Park J, McCaffrey R. Strategies of recruitment and retention of older adults with osteoarthritis for a yoga intervention: clinical trial. J Am Geriatr Soc. 2015; 63:32-33.

Cheung C, Wyman JF, Savik K. Adherence to a yoga program in older women with knee osteoarthritis. J Aging Phys Act. 2016;24(2):181-88.

Haaz S, Bingham CO, Bartlett SJ. Adherence to an 8-week yoga program for RA and OA: who drops out and why? Arthritis and Rheumatism. 2009;60. doi: 1002/art.27051.

Related to study design, e.g., not an/unclear RCT, quasi-RCT, secondary analysis (n=7)

Park J, McCaffrey R. Chair yoga: benefits for community-dwelling older adults with osteoarthritis. J Gerontol Nurs. 2012;38(5):12-22;24-
5. doi: 10.3928/00989134-20120411-50.

Park J, McCaffrey R, Newman D, Cheung C, Hagen D. The effect of Sit 'n' Fit Chair Yoga among community-dwelling older adults with osteoarthritis. Holist Nurs Pract. 2014;28(4):247-57. doi: 10.1097/HNP.0000000000000034.

Park J, McCaffrey R, Dunn D, Goodman R. Managing osteoarthritis: comparisons of chair yoga, Reiki, and education (pilot study). Holist Nurs Pract. 2011;25(6):316-26. doi: 10.1097/HNP.0b013e318232c5f9.

Kolasinski SL, Garfinkel M, Tsai AG, Matz W, Van Dyke A, Schumacher HR. Iyengar yoga for treating symptoms of osteoarthritis of the knees: a pilot study. J Altern Complement Med. 2005;11(4):689-93. doi: 10.1089/acm.2005.11.689.

Ghasemi GA, Golkar A, Marandi SM. Effects of hata yoga on knee osteoarthritis. Int J Prev Med. 2013;4(1):133-8.

Nambi GS, Shah AA. Additional effect of iyengar yoga and EMG biofeedback on pain and functional disability in chronic unilateral knee osteoarthritis. Int J Yoga. 2013;6(2):123-27. doi: 10.4103/0973- 6131.113413.

Witt CM, Michalsen A, Roll S, Morandi A, Gupta S, Rosenberg M, et al. Comparative effectiveness of a complex Ayurvedic treatment and conventional standard care in osteoarthritis of the knee - study protocol for a randomized controlled trial. Trials. 2013;14:149. doi: 10.1186/1745-6215-14-149.

Ongoing RCTs (n=9)

Study to determine effect of naturopathy and yoga treatment in patients of osteoarthritis of knee. CTRI/2010/091/001168

Dietary supplement and yogic practices for joints pain. CTRI/2020/06/025867

Effect of Ayurvedic preparation Peedanil gold with comparison to yoga module and conventional care in knee osteoarthritis patients. CTRI/2022/01/039150

Comparing effects of an online exercise plus education program to online education only in people with knee osteoarthritis: randomised controlled trial: The COPE Trial. ACTRN12620000012976

A randomised comparative effectiveness trial of YOGa and strengthening exercise for knee osteoArthritis (YOGA Trial). ACTRN12621000066886

Application of selected yoga asana on treatment of Osteoarthritis in knee. CTRI/2020/06/025912

Knee School for patients suffering from knee osteoarthritis. CTRI/2020/03/024311

Trial of 2 conservative therapies for knee arthritis patients. CTRI/2014/01/004270

Yoga for Osteoarthritis of Knee. CTRI/2022/03/040807

Full text not available (n=1)

Srivastava RN, Avasthi V, Srivastava SR, Raj S. Does yoga improve pain, stiffness and physical disability in knee osteoarthritis? – a randomized controlled clinical trial. O&C. 2015;23(2):167. doi: 10.1016/j.joca.2015.02.930.

Appendix 3: Search strategies (Chapter Three)

MEDLINE (Ovid) <1946 to November 16, 2023 >: 113 records

1. exp Mind-Body Therapies/
2. mind body therap*.mp.
3. meditat*.mp.
4. (yoga* or yogi*).mp.
5. (Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram or Hatha or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda).mp.
6. 1 or 2 or 3 or 4 or 5
7. exp Arthritis, Rheumatoid/
8. ((rheumatoid or reumatoid or revmatoid or rheumatic or reumatic or revmatic or rheumat* or reumat* or revmarthrit*) adj3 (arthrit* or artrit* or diseas* or condition* or nodule*)).mp.
9. (Sjogren* adj2 syndrome).mp.

10. (sicca adj2 syndrome).mp.

11. still* disease.mp.

12. bechterew* disease.mp.

13. caplan* adj2 syndrome).mp.

14. (felty* adj2 syndrome).mp.

15. (rheumatoid adj2 factor*).mp.

16. ((inflammatory or idiopathic) adj2 (arthritis or polyarthritis)).mp.

17. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16

18. randomized controlled trial.pt.

19. controlled clinical trial.pt.

20. randomized.ab.

21. placebo.ab.

22. drug therapy.fs.

23. randomly.ab.

24. trial.ab.

25. groups.ab.

26. 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25

27. exp animals/ not humans.sh.

28. 26 not 27

29. 6 and 17 and 28

EMBASE (Ovid) <1974 to November 16, 2023 >:

355 records

1. exp alternative medicine/

2. exp yoga/

3. exp meditation/

4. Mind body therap*.mp.

5. (Yoga* or yogi*).mp.

6. Meditat*.mp.

7. (Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram or Hatha or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda).mp.

8. 1 or 2 or 3 or 4 or 5 or 6 or 7

9. exp rheumatoid arthritis/

10. ((rheumatoid or reumatoid or revmatoid or rheumatic or reumatic or revmatic or rheumat$ or reumat$ or revmarthrit$) adj3 (arthrit$ or artrit$ or diseas$ or condition$ or nodule$)).mp.

11. (sjogren$ adj2 syndrome).mp.

12. (sicca adj2 syndrome).mp.

13. still$ disease.mp.

14. bechterew$ disease.mp.

15. (caplan* adj2 syndrome).mp.

16. (felty* adj2 syndrome).mp.

17. (rheumatoid adj2 factor*).mp.

18. ((inflammatory or idiopathic) adj2 (arthritis or

polyarthritis)).mp.

19. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18

20. Randomized controlled trial/

21. Controlled clinical trial/

22. random*.ti,ab.

23. randomization/

24. intermethod comparison/

25. placebo.ti,ab.

26. (compare or compared or comparison).ti.

27. ((evaluated or evaluate or evaluating or assessed or assess) and (compare or compared or comparing or comparison)).ab.

28. (open adj label).ti,ab.

29. ((double or single or doubly or singly) adj (blind or blinded or blindly)).ti,ab.

30. double blind procedure/

31. parallel group*1.ti,ab.

32. (crossover or cross over).ti,ab.

33. ((assign* or match or matched or allocation) adj5 (alternate or group*1 or intervention*1or patient*1 or subject*1 or participant*1)).ti,ab.

34. (assigned or allocated).ti,ab.

35. (controlled adj7 (study or design or trial)).ti,ab.

36. (volunteer or volunteers).ti,ab.

37. human experiment/

38. trial.ti.

39. 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38

40. (random* adj sampl* adj7 (cross section* or questionnaire*1 or survey* or database*1)).ti,ab. not (comparative study/ or controlled study/ or randomi?ed controlled.ti,ab. or randomly assigned.ti,ab.)

41. Cross-sectional study/ not (randomized controlled trial/ or controlled clinical study/ or controlled study/ or randomi?ed controlled.ti,ab. or control group*1.ti,ab.)

42. (((case adj control*) and random*) not randomi?ed controlled).ti,ab.

43. (Systematic review not (trial or study)).ti.

44. (nonrandom* not random*).ti,ab.

45. Random field*.ti,ab.

46. (random cluster adj3 sampl*).ti,ab.

47. (review.ab. and review.pt.) not trial.ti.

48. we searched.ab. and (review.ti. or review.pt.)

49. update review.ab.

50. (databases adj4 searched).ab.

51. (rat or rats or mouse or mice or swine or porcine or murine or sheep or lambs or pigs or piglets or rabbit or rabbits or cat or cats or dog or dogs or cattle or bovine or monkey or monkeys or trout or marmoset$1).ti. and animal experiment/

52. Animal experiment/ not (human experiment/ or human/)

53. 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52

54. 39 not 53

55. 8 and 19 and 54

PsycInfo (OVID) <1806 to November 16, 2023>: 9 records

1. exp Mind Body Therapy/

2. Mind-body therap*.mp.

3. exp Yoga/

4. (Yoga* or yogi*).mp.

5. exp Meditation/

6. Meditat*.mp.

7. (Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram or Hatha or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda).mp.

8. 1 or 2 or 3 or 4 or 5 or 6 or 7

9. exp Rheumatoid Arthritis/

10. ((rheumatoid or reumatoid or revmatoid or rheumatic or reumatic or revmatic or rheumat* or reumat* or revmarthrit*) adj3 (arthrit* or artrit* or diseas* or condition* or nodule*)).mp.

11. (Sjogren* adj2 syndrome).mp.

12. (sicca adj2 syndrome).mp.

13. still* disease.mp.

14. bechterew* disease.mp.

15. (caplan* adj2 syndrome).mp.

16. (felty* adj2 syndrome).mp.

17. (rheumatoid adj2 factor*).mp.

18. ((inflammatory or idiopathic) adj2 (arthritis or polyarthritis)).mp.

19. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18

20. (Randomized Controlled Trial or Controlled Clinical Trial or Pragmatic Clinical Trial or Equivalence Trial or Clinical Trial, Phase III).pt.

21. Randomized Controlled Trial/

22. exp Randomized Controlled Trials/

23. "Randomized Controlled Trial (topic)"/

24. Controlled Clinical Trial/

25. Controlled Clinical Trials/

26. exp Clinical Trials/

27. "Controlled Clinical Trial (topic)"/

28. Randomization/

29. Random Allocation/

30. Double-Blind Method/

31. Double Blind Procedure/

32. Double-Blind Studies/

33. Single-Blind Method/

34. Single Blind Procedure/

35. Single-Blind Studies/

36. Placebos/

37. Placebo/

38. Control Groups/

39. Control Group/

40. (random* or sham or placebo*).ti,ab,hw.

41. ((singl* or doubl*) adj (blind* or dumm* or mask*)).ti,ab,hw.

42. ((tripl* or trebl*) adj (blind* or dumm* or mask*)).ti,ab,hw

43. (control* adj3 (study or studies or trial* or group*)).ti,ab.

44. (Nonrandom* or non random* or non-random* or quasi- random* or quasirandom*).ti,ab,hw.

45. allocated.ti,ab,hw.

46. ((open label or open-label) adj5 (study or studies or trial*)).ti,ab,hw.

47. ((equivalence or superiority or non-inferiority or noninferiority) adj3 (study or studies or trial*)).ti,ab,hw.

48. (pragmatic study or pragmatic studies).ti,ab,hw.

49. ((pragmatic or practical) adj3 trial*).ti,ab,hw.

50. ((quasiexperimental or quasi-experimental) adj3 (study or studies or trial*)).ti,ab,hw.

51. (phase adj3 (III or "3") adj3 (study or studies or

trial*)).ti,hw.

52. 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51

53. 8 and 19 and 52

CINAHL (EBSCOHost) <1994 to November 16, 2023 >: 940 records

S1 (MH "Mind Body Techniques+")

S2 TX Yoga* or yogi*

S3 TX "Mind body therap*"

S4 TX Meditat*

S5 TX Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram or Hatha or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda

S6 S1 OR S2 OR S3 OR S5

S7 (MH "Arthritis, Rheumatoid+")

S8 TX Rheumatoid arthritis

S9 TX Sjogren* syndrome

S10 TX Sicca syndrome

S11 TX Still* disease

S12 TX Bechterew disease

S13 TX Caplan syndrome

S14 TX Felty* syndrome

S15 TX rheumatoid N2 factor*

S16 TX (inflammatory OR idiopathic) N2 (arthritis or polyarthritis)

S17 S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16

S18 TX randomized controlled trials

S19 MH double-blind studies

S20 MH single-blind studies

S21 MH random assignment

S22 MH pretest-posttest design

S23 MH cluster sample

S24 TI (randomised OR randomized)

S25 AB (random*)

S26 TI (trial)

S27 (MH (sample size) AND AB (assigned OR allocated OR control))

S28 MH (placebos)

S29 PT (randomized controlled trial)

S30 AB (control W5 group)

S31 MH (crossover design)

S32 MH (comparative studies)

S33 AB (cluster W3 RCT))

S34 S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33

S35 ((MH animals+ OR MH animal studies OR TI animal model*) NOT MH human)

S36 S34 NOT S35

S37 S6 AND S17 AND S36

Cochrane Central Register of Controlled Trials (CENTRAL) <1996 to November 16, 2023>: 786 records

#1 MeSH descriptor: [Mind-Body Therapies] explode all trees

#2 Meditation (Word variations have been searched)

#3 yoga* (Word variations have been searched)

#4 Mind body therapies (Word variations have been searched)

#5 (asana* or pranayam* or dhyan* or meditat* or ashtanga or bikram or hatha or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda)

#6 #1 or #2 or #3 or #4 or #5

#7 MeSH descriptor: [Arthritis, Rheumatoid] explode all trees

#8 (Sjogren* adj2 syndrome).mp. (Word variations have been searched)

#9 (Sicca adj2 syndrome).mp. (Word variations have been searched)

#10 Still* disease.mp. (Word variations have been searched)

#11 Bechterew* disease.mp. (Word variations have been searched)

#12 (Caplan* adj2 syndrome).mp. (Word variations have been searched)

#13 (Felty* adj2 syndrome).mp. (Word variations have been searched)

#14 (rheumatoid adj2 factor*).mp. (Word variations have been searched)

#15 ((inflammatory or idiopathic) adj2 (arthritis or polyarthritis)).mp. (Word variations have been searched)

#16 #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15

#17 MeSH descriptor: [Randomized Controlled Trial] explode all trees

#18 MeSH descriptor: [Controlled Clinical Trial] explode all trees

#19 placebo* (Word variations have been searched)

#20 ("randomised clinical trial") (Word variations have been searched)

#21 (trial*) (Word variations have been searched)

#22 MeSH descriptor: [Randomized Controlled Trials as Topic] explode all trees

#23 #17 OR #18 OR #19 OR #20 OR #21 OR #22

#24 #6 AND #16 AND #23

Allied and Complementary Medicine (AMED) (Ovid) <1985 to November 16, 2023>: 10 records

1 exp Mind body medicine/

2 exp Yoga/

3 exp Meditation/

4 Mind body medicine*.mp.

5 (Yoga* or yogi*).mp.

6 Meditat*.mp.

7 (Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram or Hatha or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda).mp.

8 1 or 2 or 3 or 4 or 5 or 6 or 7

9 exp Arthritis rheumatoid/

10 ((rheumatoid or reumatoid or revmatoid or rheumatic or reumatic or revmatic or rheumat* or reumat* or revmarthrit*) adj3 (arthrit* or artrit* or diseas* or condition* or nodule*)).mp.

11 (Sjogren* adj2 syndrome).mp.

12 (sicca adj2 syndrome).mp.

13 still* disease.mp.

14 bechterew* disease.mp.

15 (caplan* adj2 syndrome).mp.

16 (felty* adj2 syndrome).mp.

17 (rheumatoid adj2 factor*).mp.

18 ((inflammatory or idiopathic) arthritis)).mp.

19 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18

20 (random* or factorial* or placebo* or assign* or

allocat* or crossover*).tw.

21 (cross adj over*).tw.

22 (trial* and (control* or comparative)).tw.

23 ((blind* or mask*) and (single or double or triple or treble)).tw.

24 (treatment adj arm*).tw.

25 (control* adj group*).tw.

26 (phase adj (III or three)).tw.

27 (versus or vs).tw.

28 rct.tw.

29 RANDOM ALLOCATION/

30 DOUBLE BLIND METHOD/

31 placebos/

32 randomized controlled trials/

33 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32

34 8 and 19 and 33

SPORTDiscus (EBSCOHost) <2004 to November 16, 2023>: 4 records

S1 SU Mind body therapy

S2 SU Yoga

S3 SU Meditation

S4 TX Mind body therap*

S5 TX Yoga* or yogi*

S6 TX Meditat*

S7 TX Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram or Hatha or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda

S8 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7

S9 SU rheumatoid arthritis

S10 TX Rheumatoid arthritis

S11 TX Sjogren* syndrome

S12 TX Sicca syndrome

S13 TX Still* disease

S14 TX Bechterew disease

S15 TX Caplan syndrome

S16 TX Felty* syndrome

S17 TX rheumatoid N2 factor*

S18 TX (inflammatory OR idiopathic) N2 (arthritis or polyarthritis)

S19 S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18

S20 TX Randomized controlled trials

S21 SU Randomized controlled trials

S22 TX Double-blind studies

S23 TX Single-blind studies

S24 TX Random assignment

S25 TX Pretest-posttest design

S26 TX Cluster sample

S27 TX Placebos

S28 TX randomised or randomized

S29 TX random*

S30 TX trial*

S31 S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S30

S32 S8 AND S19 AND S31

Web of Science <1998 to November 16, 2023>: 82 records

#1 ALL=(yoga* OR “mind body therap*” OR meditation OR yogi* OR asana* OR pranayam* OR dhyan* OR meditat* OR ashtanga OR bikram OR hatha OR iyengar OR kripalu OR kundalini OR vinyasa OR raja OR radja OR bhakti OR jnana OR kriya* OR karma OR yama OR niyama OR pratyahara OR dharana OR samadhi OR bandha OR mudra* OR chanda OR sivananda)

#2 ALL=("Rheumatoid arthritis" or "sjogren* syndrome" or "sicca syndrome" or "still* disease" or "bechterew* disease" or "caplan* syndrome" or "felty* syndrome" or rheumatoid factor or "inflammatory arthritis" or "idiopathic arthritis" or "inflammatory polyarthritis")

#3 ALL=((“randomized controlled trial” OR “controlled clinical trial” OR “clinical trial” OR “clinical trials" OR placebo* OR "random allocation" OR "double-blind method" OR "single-blind method" OR "cross-over studies"))

#4 (ALL=((“randomized controlled trial” OR “controlled clinical trial” OR “clinical trial” OR “clinical trials" OR placebo* OR "random allocation" OR "double-blind method" OR "single-blind method" OR "cross-over studies"))) AND ALL=((randomised OR randomized OR randomisation OR randomisation OR placebo* OR (random* AND (allocat* OR assign*)) OR (blind* AND (single OR double OR treble OR triple))))

#5 #3 OR #4

#6 #1 AND #2 AND #5

Turning Research Into Practice (TRIP); < 2014 to November 16, 2023>: 12 records (RCTs)

(yoga* OR "mind body therapies" OR yogi* OR asana* OR pranayam* OR dhyan* OR meditation OR meditate OR ashtanga OR bikram OR hatha OR iyengar OR kripalu OR kundalini OR vinyasa OR raja OR radja OR bhakti OR jnana OR kriya* OR karma OR yama OR niyama OR pratyahara OR dharana OR samadhi OR bandha OR mudra* OR chanda OR sivananda)

AND

("rheumatoid arthritis" OR "sjogren* syndrome" OR "sicca syndrome" OR "still* disease" OR "bechterew* disease" OR "caplan* syndrome" OR "felty* syndrome" OR "rheumatoid factor" or inflammatory arthritis OR idiopathic arthritis OR inflammatory polyarthritis)

AND

(randomised controlled trial OR randomized controlled trial OR controlled clinical trial* OR clinical trial* OR placebo* OR random*)

AYUSH Research Portal (Ministry of AYUSH, Government of India) <Date of search: November 16, 2023: 10 records

Medical system: yoga and naturopathy

Category: preclinical research, clinical research (Evidence grade - A, B, C) and fundamental research

Body system: musculoskeletal

Disease (English): Rheumatoid/seropositive arthritis (ICPC-L88, ICD- M05, M06, M08, M45)

EVIDENCE GRADE – A:4 EVIDENCE GRADE – B:6 EVIDENCE GRADE – C:0

A Bibliography of Indian Medicine (ABIM)<Date of search: November 16, 2023>: 3 records

Search terms used: yoga and rheumatoid arthritis

Complementary and alternative medicine (CAM-QUEST) < Date of search: November 16, 2023>: 42 records

Searched for the following:

Disease pattern: pain (1155 results) to disease: chronic pain (209 results) to therapy: mind body medicine (75 results) to study design: randomized trial (33 results)

Searched for the following:

Therapy: Mind-body medicine (3708 results) to disease pattern: Musculoskeletal-/Connective tissue system (388 results) to disease: Arthritis (24 results) to study design: Randomized trial (13 results)

Physiotherapy Evidence Database (PeDro) <from 1999 to November 16, 2023>: 15 records

Searched terms used: yoga and rheumatoid arthritis

OpenGrey (Data Archiving and Network Services) <from 1997 to November 16, 2023>: 0 records

Search terms used: Yoga and rheumatoid arthritis

EthOS <from 2009 to August 26, 2022>: 0 records

Search terms used: yoga and rheumatoid arthritis

ProQuest Dissertations and Theses (via Web of Science) <from 1902 to November 16, 2023>: 23 records

#1 TS=((yoga* OR mind body therap* OR yogi* OR asana* OR pranayam* OR dhyan* OR meditat* OR ashtanga OR bikram OR hatha OR iyengar OR kripalu OR kundalini OR vinyasa OR raja OR radja OR bhakti OR jnana OR kriya* OR karma OR yama OR niyama OR pratyahara OR dharana OR samadhi OR bandha OR mudra* OR chanda OR sivananda))

#2 TS=(("rheumatoid arthritis" OR "sjogren* syndrome" OR "sicca syndrome" OR "still* disease" OR "bechterew* disease" OR "caplan* syndrome" OR "felty* syndrome" OR "rheumatoid factor" or inflammatory arthritis OR idiopathic arthritis OR inflammatory polyarthritis))

#3 TS=((randomised controlled trial OR randomized controlled trial OR controlled clinical trial* OR clinical trial* OR placebo* OR random* or trial*))

#4 #1 AND #2 AND #3

DART-Europe-e-theses portal <from 2005 to November 16, 2023>: 1 record

Search terms used: yoga and rheumatoid arthritis

Appendix 4: Excluded studies with reasons for exclusion (Chapter Three)

Full-text studies excluded (n = 16)

Related to population (ineligible age group) (n = 2)

Evans S, Moieni M, Lung K, Tsao J, Sternlieb B, Taylor M, et al. Impact of iyengar yoga on quality of life in young women with rheumatoid arthritis. Clin J Pain. 2013;29(11):988-97. doi: 10.1097/AJP.0b013e31827da381.

Middleton KR, Ward MM, Haaz MS. et al. Feasibility and assessment of outcome measures for yoga as self-care for minorities with arthritis: a pilot study. Pilot Feasibility Stud. 2018;4:53. doi:10.1186/s40814- 018-0248-x.

Related to outcome (ineligible outcomes) (n = 3)

Dubey V. Efficacy of yoga therapy in rheumatoid arthritis patients with normal values on measures of inflammation. Int J Rheum Dis. 2016;19:21.

Dash M, Telles S. Improvement in hand grip strength in normal volunteers and rheumatoid arthritis patients following yoga training. Indian J Physiol Pharmacol 2001;45:355-60.

Moonaz SH, Bingham CO, Wissow L, et al. Yoga in sedentary adults with arthritis: effects of a randomized controlled pragmatic trial. J Rheumatol 2015;42:1194-202.

Related to study design (e.g., pilot study (unclear if randomised), quasi-RCT, study protocol) (n = 7)

Evans S, Moieni M, Taub R, Subramanian SK, Tsao JC, Sternlieb B, et al. Iyengar yoga for young adults with rheumatoid arthritis: results from a mixed-methods pilot study. J Pain Symptom Manage. 2010;39(5):904-13. doi: 10.1016/j.jpainsymman.2009.09.018.

Evans S, Cousins L, Tsao JC, Subramanian S, Sternlieb B, Zeltzer LK. A randomized controlled trial examining Iyengar yoga for young adults with rheumatoid arthritis: a study protocol. Trials. 2011;12:19. doi: 10.1186/1745-6215-12-19.

Ward L, Stebbings S, Athens J, Cherkin D, Baxter DG. Yoga for pain and sleep quality in rheumatoid arthritis: study protocol for a pilot randomized controlled trial. Phys Ther

Rev 2014;19:266-76. doi: 10.1179/1743288X14Y.0000000139.

Bosch PR, Traustadóttir T, Howard P, Matt KS. Functional and physiological effects of yoga in women with rheumatoid arthritis: a pilot study. Altern Ther Health Med. 2009;15(4):24-31.

Badsha H, Chhabra V, Leibman C, Mofti A, Kong KO. The benefits of yoga for rheumatoid arthritis: results of a preliminary, structured 8 - week program. Rheumatol Int. 2009;29(12):1417-21. doi: 10.1007/s00296-009-0871-1.

Greenfield RH. Flexible? Yoga and rheumatoid arthritis. Integrative Medicine Alert. 2009;12:29-30.

Zochling J. Update on complementary and alternative medicines for arthritis. Medicine Today. 2009;10:71-6.

Full text not available/conference abstract (n = 4)

Puksic S, Mitrovic J, Culo MI, Zivkovic M, Orehovec B, Lucijanic M, et al Yoga leads to sustained improvement in fatigue and mood in rheumatoid arthritis: preliminary results of a randomized controlled trial. Ann Rheum Dis. 2020;79:528. doi:10.1136/annrheumdis-2020- eular.1876.

Mahidashtizad S, Salajegheh A. Effects of a yoga program on pain relief, reducing anxiety and extended range of motion of knee in rheumatoid arthritis patients. Annals of the Rheumatic Diseases 2013;71:756.

Haslock I, Monro R, Nagarathna R,Nagendra HR, Raghuram NV. Measuring the effects of yoga in rheumatoid arthritis. Rheumatol 1994;33:787–88. doi: 10.1093/rheumatology/33.8.787-a.

Gautam S, Chaurasia P, Rana D, Kumar U, Dada R. Yoga reduces sperm oxidative DNA damage and improves fertility potential in infertile men with rheumatoid arthritis on disease-modifying antirheumatic drugs. 45th Annual Meeting of American Society of Andrology (ASA); 2020 Apr; virtual.

Appendix 5: Search strategies (Chapter Four)

Medline (Ovid) Date of search: 07 Nov 2024;746 records

1. exp Yoga/

2. exp Meditation/

3. exp Mind-Body Therapies/

4. "mind-body therap*".mp.

5. meditat*.mp.

6. (yoga* or yogi*).mp.

7. (asana* or pranayam* or dhyan* or ashtanga or bikram or hatha* or nidra or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda).mp.

8. 1 or 2 or 3 or 4 or 5 or 6 or 7

9. exp Arthritis/

10. (osteoarthr* or osteo-arthr*).mp.

11. (arthrit* or coxarthr* or chondrocalcinos#s or pseudogout or gout* or periarthriti* or oligoarthrit* or "r?eumatic fever*" or sacroiliit* or spondylarthrit*).mp.

12. "arthrosis deformans".mp.

13. (degenerative adj2 arthrit*).mp.

14. "degenerative joint disease*".mp.

15. (non-inflammatory adj3 arthrit*).mp.

16. ((inflammatory or idiopathic) adj2 (arthrit* or polyarthrit*)).mp.

17. ((r?eumat* or r?eumart* or revmatoid) adj3 (arthrit* or artrit* or diseas* or condition* or nodule* or factor*)).mp.

18. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17

19. 8 and 18

Embase (Ovid) Date of search: 07 Nov 2024; 330 records

1. exp alternative medicine/

2. exp yoga/

3. exp meditation/

4. “Mind body therap*”.mp.

5. (Yoga* or yogi*).mp.

6. Meditat*.mp.

7. (Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram

or Hatha* or Nidra or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda).mp.

8. 1 or 2 or 3 or 4 or 5 or 6 or 7

9. exp Arthritis/

10. (osteoarthr* or osteo-arthr*).mp.

11. (arthrit* or coxarthr* or chondrocalcinos#s or pseudogout or gout* or periarthriti* or oligoarthrit* or "r?eumatic fever*" or sacroiliit* or spondylarthrit*).mp.

12. "arthrosis deformans".mp.

13. (degenerative adj2 arthrit*).mp.

14. "degenerative joint disease*".mp.

15. (non-inflammatory adj3 arthrit*).mp.

16. ((inflammatory or idiopathic) adj2 (arthrit* or polyarthrit*)).mp.

17. ((r?eumat* or r?eumart* or revmatoid) adj3 (arthrit* or artrit* or diseas* or condition* or nodule* or factor*)).mp.

18. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17

19. (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or f2f or structured or guide*) adj3 (interview* or discussion* or questionnaire*)).ti,ab.

20. (focus group* or qualitative or ethnograph* or fieldwork or "field work" or "key informant").ti,ab.

21. exp interview/

22. exp verbal communication/

23. qualitative research/

24. 19 or 20 or 21 or 22 or 23

25. 8 and 18 and 24

CINAHL Plus (EBSCOhost) Date of search: 07 Nov 2024; 52 records

S1 (MH "Yoga+")

S2 (MH "Mind Body Techniques+")

S3 (MH "Meditation")

S4 yoga* or yogi*

S5 "mind body therap*"

S6 meditat*

S7 asana* or pranayam* or dhyan* or ashtanga or bikram or hatha* or nidra or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda

S8 S1 or S2 or S3 or S4 or S5 or S6 or S7

S9 (MH "Arthritis+")

S10 osteoarthr* or osteo-arthr*

S11 arthrit* or coxarthr* or chondrocalcinos?s or pseudogout or gout* or periarthriti* or oligoarthrit* or "r#eumatic fever*" or sacroiliit* or spondylarthrit*

S12 “Arthrosis deformans”

S13 degenerative N2 arthritis

S14 degenerative joint disease*

S15 non-inflammatory N3 arthrit*

S16 (inflammatory or idiopathic) N2 (arthrit* or polyarthrit*)

S17 (r#eumat* or r#eumart* or revmatoid) N3 (arthrit* or artrit* or diseas* or condition* or nodule* or factor*)

S18 S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17

S19 ("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or f2f or structured or guide*) N3 (interview* or discussion* or questionnaire*)

S20 focus group* or qualitative or ethnograph* or fieldwork or "field work" or "key informant"

S21 S19 or S20

S22 S8 and S18 and S21

PsycInfo (Ovid) Date of search: 07 Nov 2024; 87 records

1. exp Mind Body Therapy/

2. “Mind-body therap*”.mp.

3. exp Yoga/

4. (Yoga* or yogi*).mp.

5. exp Meditation/

6. Meditat*.mp.

7. (Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram or Hatha* or Nidra or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda).mp.

8. 1 or 2 or 3 or 4 or 5 or 6 or 7

9. exp Arthritis/

10. (osteoarthr* or osteo-arthr*).mp.

11. (arthrit* or coxarthr* or chondrocalcinos#s or pseudogout or gout* or periarthriti* or oligoarthrit* or "r?eumatic fever*" or sacroiliit* or spondylarthrit*).mp.

12. "arthrosis deformans".mp.

13. (degenerative adj2 arthrit*).mp.

14. "degenerative joint disease*".mp.

15. (non-inflammatory adj3 arthrit*).mp.

16. ((inflammatory or idiopathic) adj2 (arthrit* or polyarthrit*)).mp.

17. ((r?eumat* or r?eumart* or revmatoid) adj3 (arthrit* or artrit* or diseas* or condition* or nodule* or factor*)).mp.

18. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17

19. 8 and 18

AMED (Ovid) Date of search: 07 Nov 2024; 68 records

1. Mind body medicine/

2. exp Yoga/

3. exp Meditation/

4. ("mind body" adj (medicine or therap*)).mp.

5. (Yoga* or yogi*).mp.

6. Meditat*.mp.

7. (Asana* or Pranayam* or Dhyan* or Ashtanga or Bikram or Hatha* or Nidra or Iyengar or Kripalu or Kundalini or Vinyasa or Raja or Radja or Bhakti or Jnana or Kriya* or Karma or Yama or Niyama or Pratyahara or Dharana or Samadhi or Bandha or Mudra* or Chanda or Sivananda).mp.

8. 1 or 2 or 3 or 4 or 5 or 6 or 7

9. exp Arthritis/

10. (osteoarthr* or osteo-arthr*).mp.

11. (arthrit* or coxarthr* or chondrocalcinos#s or pseudogout or gout* or periarthriti* or oligoarthrit* or "r?eumatic fever*" or sacroiliit* or spondylarthrit*).mp.

12. "arthrosis deformans".mp.

13. (degenerative adj2 arthrit*).mp.

14. "degenerative joint disease*".mp.

15. (non-inflammatory adj3 arthrit*).mp.

16. ((inflammatory or idiopathic) adj2 (arthrit* or

polyarthrit*)).mp.

17. ((r?eumat* or r?eumart* or revmatoid) adj3 (arthrit* or artrit* or diseas* or condition* or nodule* or factor*)).mp.

18. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17

19. 8 and 18

Web of Science Date of search: 07 Nov 2024; 41 records

#1 ALL= (yoga* or “mind body therap*” or meditation or yogi* or asana* or pranayam* or dhyan* or meditat* or ashtanga or bikram or hatha* or nidra or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda)

#2 ALL=((“Osteoarthritis” or osteoarthr* or osteo-arthr* or “coxarthrosis” or degenerative arthritis or degenerative joint disease* or non-inflammatory arthritis))

#3 ALL=(((r?eumat* or r?eumart* or revmatoid) N3 (arthrit* or artrit* or diseas* or condition* or nodule* or factor*)))

#4 ALL=((focus group* or interview* or narration or qualitative or ethnograph* or fieldwork or "field work" or "key informant"))

#5 #3 OR #2

#6 #5 AND #4 AND #1

ProQuest Dissertations and Theses (via Web of Science)

Date of search: 07 Nov 2024; 6 records

#1 TS=((yoga* or mind body therap* or yogi* or asana* or pranayam* or dhyan* or meditat* or ashtanga or bikram or hatha* or nidra or iyengar or kripalu or kundalini or vinyasa or raja or radja or bhakti or jnana or kriya* or karma or yama or niyama or pratyahara or dharana or samadhi or bandha or mudra* or chanda or sivananda))

#2 TS=((osteoarthritis or osteoarthr* or osteo-arthr* or coxarthrosis or degenerative adj2 arthritis or degenerative joint disease* or non- inflammatory arthritis))

#3 TS=(("rheumatoid arthritis" OR "rheumatoid factor" or inflammatory arthritis OR idiopathic arthritis OR inflammatory polyarthritis))

#4 TS=((focus group* or qualitative or ethnograph* or fieldwork or "field work" or "key informant"))

#5 #2 OR #3

#6 #1 AND #4 AND #5

Appendix 6: Excluded studies with reasons for exclusion (Chapter Four)

Full-text studies excluded (n=6)

Ineligible phenomena of interest (n=3)

Shariff F, Carter J, Dow C, Polley M, Salinas M, Ridge D. Mind and body management strategies for chronic pain and rheumatoid arthritis. QualHealthRes.200;19(8):1037-49.doi: 10.1177/1049732309341189.

Hipwell AE, Turner A, Barlow JH. Experiences of living with and self-managing arthritis: a qualitative exploration from Punjabi Sikh women's perspectives. Rheumatology (Oxford). 2008;48(2):159.

Hawtin H, Sullivan C. Experiences of mindfulness training in living with rheumatic disease: an interpretative phenomenological analysis. BJOT. 2011;74(3):137-42.

Conference abstract (n=2)

Sadana V, Cartwright T, Cahill M. A mixed methods evaluation of Viniyoga therapy intervention for rheumatoid arthritis. Eur J Integr Med. 2021;48:102081.

Greysen H. "It was just my right pace": a qualitative study exploring yoga practice in adults with rheumatoid arthritis. In: ACR/ARHP Combined Abstract Session: Rehabilitation [Internet]. 2015 ACR/ARHP Annual Meeting: 2015 Nov 08; Arthritis and Rheumatology; 2015 Sep 09 [cited 2024 Nov 08]. Available from: https://acrabstracts.org/abstract/it-was-just-my-right-pace-a-qualitative-study-exploring-yoga-practice-in-adults-with-rheumatoid- arthritis/.

Protocol (n=1)

Middleton KR, Ward MM, Haaz S, Velummylum S, Fike A, Acevedo AT, et al. A pilot study of yoga as self-care for arthritis in minority communities. Health Qual Life Outcomes. 201;11:55. doi: 10.1186/1477-7525-11-55.

Appendix 7: Synthesised findings, along with their categories, findings, and illustrations.

Synthesised finding 1: Categories, findings, and illustrations.

Finding and credibility assigned	Illustration, study author, and page number	Category	**Yoga, arthritis, and the body:** The anticipated and experienced impacts of yoga on physical well-being influenced yoga practice in people with arthritis.
Hesitance regarding suitability due to unfamiliarity with yoga and being concerned about inability to perform certain poses. (U)	"I saw people at gym doing it (yoga) and you're like 'yeah right' I'm never going to be able to do that I'm not even gonna try….at first, I didn't even consider it. You hear yoga and arthritis and you just don't think the two mix." (Evans2011) (p4)	Yoga practice seemed "an unknown territory" that might aggravate arthritis symptoms.	
Exercise preference. (U)	"I stopped doing most of the floor yoga…getting up and down from the floor is more challenging." (Cheung2022) (p7)		
Physical concerns. (U)	"I'm not gonna try yoga because I'm scared that it's gonna make me have a flare-up and I'm gonna be in pain…" (Ward2011) (p217)		
Health status. (U)	"I can do yoga, but I just have to be conscious about when I feel that flutter [from my heart valve problem]." (Cheung2022) (p7)		
Pain/discomfort. (U)	"Today I practiced in the morning, I didn't feel as motivated to do it. Because I had some pain. But afterwards I felt somewhat better." (Middleton2017) (p86)		
Symptom burden – persistent flares. (U)	''I had to stop doing yoga because of my RA. I actually tried yoga again recently, but it caused a flare, so, I've got to stop doing that." (Greysen2017) (p490)		

Perception of no benefits. (U)	“I don’t know that incorporating the yoga has greatly helped because I [already] do so much.” (Cheung2022) (p8)	Uncertainty about yoga’s benefits on arthritis symptoms discouraged yoga practice.	
Ambivalence about pain improvement. (U)	"And in terms of the pain, I think some days I thought ‘‘Oh wow, it’s really working’’ and some days I don’t know. It’s hard to really tell." (Evans2010) (p910)		
Reduction of pain and improvement of movement. (U)	"It makes my body feel better and I have less pain." (Park2011) (p322)	Experiencing relief from arthritis symptoms as a result of yoga practice.	
Physical benefit. (U)	“ I am very happy because I have learned yoga, it is something new for me, it is helping me feel better, sleep better, to stretch and that helps me in my arthritis and I forget that I have it/suffer from it.” (Middleton) (p86)		
Good effects produced from yoga. (U)	“Helps relieve the pain.” (Cheung2022) (p6)		
Physical benefit. (U)	“I’ve been doing the yoga, and it really seems to be keeping the muscle tone…keeping it strong and in shape.” (Cheung2022) (p6)		
Less swelling. (U)	“The swelling in my knee has gone down probably 80%, which is really good, and I attribute it to the yoga.” (Cheung2022) (p33)		
Less pain and developed stronger leg muscles and muscle tone. (U)	“Mine [KOA] improved a lot…I really don’t complain now a lot about knee pain. I’ve developed more muscles in my legs, too, so that kind of helps me.” (Cheung2022) (p33)		
Yoga relieved OA symptoms. (U)	“I think this stuff [yoga] really works. My pain is less, it helps me keep going. I am going to keep doing it.” (Cheung 2015) (p21)		
A sense of pain relief. (U)	“I felt at ease with all my joints and my body.” (Evans2010) (p910)		
Physical health benefits – pain reduction. U)	“Pains started reducing and before it used to		

	be eight, nine, level nine and then it started coming down three, four to two now or sometimes, some, sometimes it's just gone completely like now, I've got nothing, no pain whatsoever." (Cartwright2020) (p21)		
Physical benefit. (U)	"Class was good today. I was on the mat for the first time. I feel I got a better workout on the mat. After we worked on our feet mine actually felt better. I seem to have more energy when I left class." (Middleton2017) (p86)		
An improvement in morning symptoms. (U)	"When I started, in the mornings, I would wake up with a little bit of pain in my elbow or knee or something and I really don't have that at all anymore." (Evans2010) (p910)		
Particular poses that had an action on corresponding body areas. (U)	"Some of those poses, like opening the legs up or even stretching them, helped a little bit with my range of motion and it relaxed around my joints, especially the ones that hurt the most." (Evans2011) (p6)		
Physical health benefits - improved sleep. (U)	"I'm sleeping without pain because I'm not in pain, so I can lie down and just sleep and get up when the time comes to get up without being just exhausted for the whole day." (Cartwright2020) (p3)		
Regular yoga practice helped participants become more conscious about their bodies and participate in other physical activities. (U)	"I think about my posture more whether I am standing or sitting, even when I am doing dishes." (Cheung2015) (p21)	Yoga seemed to elevate body awareness and physical vitality translating into peoples' daily lives.	
Participants reported practising yoga along with other forms of exercise to stay healthy	" I have always been active. I bike, hike, and do Pilates. I now add yoga." (Cheung2015)		

and active. (U)	(p21)		
A sense of being more aware of body posture, alignment, and flexibility. (U)	"I can see how yoga can correct your body position if you keep on doing that...I'm more aware of how I can do that with my muscles too; lifting up your leg to make it straighter instead of letting your legs do whatever they want." (Evans2011) (p6)		
Increase in physical vitality generalised to many facets of living. (U)	"(Yoga) just in general helped my energy level so that helped across the board with life." (Evans2011) (p5)		
Awareness of long-term tension in the body and the development of a misaligned body posture to accommodate painful joints. (U)	"I always feel like my body is caved inward. I'm always trying to protect my joints, and I've sort of learned and feel that after every class, I feel more open." (Evans2011) (p6)		
Improved general functioning. (U)	"It made me feel better .overall it helped, just in general helped my energy level so that helped across the board with life." (Evans2010) (p910)		
An expanded awareness that extended from an internal knowledge of stress response to a structural awareness of how their bodies, including affected joints, may be misaligned. (U)	"Never been that in tune with my body that I could feel the physical reaction of my stress." (Evans2011) (p6)		
Reduction in medication dosage. (U)	"Halfway through this we reduced my dose from 15 to 7.5mgs so I'm on half the dose of methotrexate and I'm doing fine on it." (Cartwright2020) (p3)	Yoga practice was perceived to reduce reliance on arthritis medication for pain relief.	
Yoga helped reduce medication and still manage the pain. (U)	''get off one of the crutches'' (Evans2010) (p910)		

Synthesised finding 2: Categories, findings, and illustrations.

Finding and credibility assigned	Illustration, study author, and page number	Category	**Yoga, arthritis, and the mind**: Levels of motivation and perceived impact on mental well- being influenced yoga practice in people with arthritis.
Self-efficacy: novice. (U)	"I tried to do the exercise on Wednesday but I don't think I did very well. I need to keep my mind only on what I am doing…I tried to do a ten minute meditation. I was concentrating on just one sentence. It was hard to stay focus. I tried just seeing it in my head like a tie on tape but was hard. I don't know if I am doing this correctly." (Middleton2017) (p86)	Wavering intrinsic motivations (concentration, self- efficacy, and self-assurance) negatively influenced yoga practice.	
Barriers - lack of concentration. (U)	"I am also confused because when I relax in the moment that I am doing the exercise my mind starts to think about what I will be doing later." (Middleton2017) (p86)		
Self-assurance. (U)	"I question my own accuracy." (Cheung2022) (p7)		
Motivated to practice yoga because of one's own enthusiasm or interest. (U)	"I like [yoga in the water] so much that it motivates me to get out early in the morning, and I feel great." (Cheung2022) (p6)	High levels of intrinsic motivations (personal interest in yoga, prioritising health, self-efficacy, self-assurance, and self-confidence) facilitated yoga practice.	
Desire for physical fitness. (U)	"I'm older now and I needed to do something about balance and posture." (Greysen2017) (p490)		
Health was a greater priority than busy schedules. (U)	"Prioritised and made time because it's my health." (Cartwright2020) (p10)		

Greater appreciation for the value of self-care. (U)	“What’s number one is me and I need to look after myself.” (Cartwright2020) (p10)		
Self-efficacy: improvement. (U)	“It was a very good experience because I didn’t need help. Although I am not sure it was perfect but just the experience, I hope to perfect it.” (Middleton) (p86)		
Self-efficacy: novice. (U)	"I try to do it when I exercise I can and I want to learn them and that way I won’t depend on the instructors, soon she will leave us alone and we will have to do it ourselves." (Middleton) (p86)		
Self-efficacy: improvement. (U)	“Practiced for 30 minutes. no Pain. I’m getting into a better flow with my home practice, but still need to use the manual.” (Middleton2017) (p86)		
Increased self-efficacy extended to physical activity. (U)	”Every morning I try to stay more active now...even if I have some pain.” (Evans2011) (p7)		
Confidence in own ability to practice yoga. (U)	“It’s easy, and there’s no equipment.” (Cheung2022) (p7)		
A sense of pride or accomplishment in their physical abilities and self- confidence. (U)	“I was pretty proud of myself for getting through it. When I do certain moves, I can feel pretty good about myself.” (Greysen2017) (p491)		
Self-assurance. (U)	"This is an activity that I actually can do. I use those home practice instruction sheet[s] we got for the study." (Cheung2022) (p7)		
There was a sense that if only they	“If I had learned this even when I was in	Extrinsic motivations	

had known about yoga classes earlier in their diagnosis, they could have prevented much of the physical and psychological impairment they had experienced. (U)	high school, God what a great thing to learn at a young age, because sometimes pain can be worsened because we're thinking about it too much so if you are in a position to learn how to quiet that, it will help anything. If you can learn to do that when you are young, how much damage would you have in the long run?" (Evans2010) (p910)	(doctor's advice, reduced price of yoga sessions, improvement in other health conditions, exposure to yoga, and peer/family support) positively influenced yoga practice in arthritis.	
Reduced price of yoga classes. (U)	"I won a free one-month pass to a yoga studio at the auction at my daughter's school." (Greysen2017) (p489)		
Suggestion of physician. (U)	"When I got into the Pain Management Program, they suggested that I get into yoga." (Greysen2017) (p489)		
Motivator-being influenced by others. (U)	"A group of friends here at work had talked about doing Bikram yoga, and there was a deal, so I tried it." (Greysen2017) (p490)		
Social/emotional support. (U)	"Today I did standing poses, my son did them too, and he was also helping me by telling me how. Then I felt that gradually, the stretches are rather easy to do." (Middleton2017) (p86)		
Measurable improvements to other conditions – diabetes, high blood pressure. (U)	"I went to see the doctor a couple of weeks ago and she said your blood, we, we took a blood test before that so they were analysing my bloods, she said your diabetes has gone down, your blood pressure has		

	gone down so I was really chuffed. I can only put it down to the therapy." (Cartwright 2020) (p3)		
Perceived improvements to health strongly motivated the patients to continue with their yoga practice. (C)	"It's really inspired me to do the exercises regularly." (Cartwright2020) (p9)		
Mental/emotional benefit. (U)	"I am very grateful for doing yoga. I am more tranquil and I can sleep more because I practice breathing and letting go of everything in my mind." (Middleton) (p86)	Perception of improvements in mental well-being could encourage yoga practice.	
Mental/emotional benefit. (U)	"When I do the exercises I feel good, I am thinking about what I am doing, I feel very centered in thought and spirit." (Middleton2017) (p86)		
Great impact on emotional well-being and mood. (U)	"It was very helpful for my mind more so than anything." (Evans2011) (p7)		
Improvements in depressive and anxious symptoms. (U)	"Before doing the yoga, I was having some troubles at home. Very depressing. So I was in bed a lot more…I just locked myself up and stayed in my room but now I've noticed that I'm outside of my room now, I'm out with my family, in the kitchen with my mom, I'm visiting my friends, I'm not staying home like I was before. I still get sad a little bit but it's not like the depression that used to haunt me a lot more before…Now I see a brighter day. I'm looking forward to tomorrow, and the next		

	day whereas before I wouldn't even look." (Evans2011) (p8)		
Benefits after the yoga program. (U)	"My rheumatologist even noticed the change in my fatigue and mood…" (Evans2010) (p911)		
Significant increases in mood and mental well-being. (U)	"I'm just happy and everybody can see that I'm happy." (Cartwright2020) (p9)		
Mental reframing and taking control. (U)	"The strength you have within yourself to make a difference." (Cartwright2020) (p10)		
Focused breathing enabled them to reduce their anxiety in multiple situations and this transferability helped develop their resilience. (U)	"When you do deep breathing your mind is somewhere else, you forget about your worries or whatever." (Cartwright2020) (p11)		

Synthesised finding 3: Categories, findings, and illustrations.

Finding and credibility assigned	Illustration, study author, and page number	Category	**Yoga, arthritis, and the mind-body impact:** The experience of mind-body benefits of yoga fostered a positive outlook on coping with arthritis and encouraged ongoing engagement with yoga practice in people with arthritis.
Yoga equipped participants with the tools to see themselves as efficacious and capable of managing their functioning. (U)	"I just learned that always try new things, not to think you can't do it and keep ongoing in life like that…don't be scared…find a way that you can do it." (Evans2011) (p7)	Practising yoga gave people with arthritis, a sense of empowerment i.e., the ability to take control of their condition.	
Rather than being a panacea for pain and symptom relief, yoga provided a tool to manage pain. (U)	"My pain is still there…but now the difference is that I could reduce the pain by relaxing and just learning to be stress- free and just to be more peaceful. I've learned that if I'm peaceful and more stress free my pain eases away a little. So I'm doing better now." (Evans2010) (p910)		
Benefits – self-management. (U)	"…there's no way we can control it but it's, it's just managing how we can control it. So, finding those techniques that can help us get through it or, you know." (Ward2011) (p215)		
Increased agency arising from confidence in taking charge of health. (U)	"I like to walk everywhere now." (Cartwright2020) (p9)		
Self-management at home. (U)	"No, it's easier to do it at home,' cause then you can choose your own time, you're not getting there by 1 o'clock or 10 o'clock or whatever, you can please yourself when		

	you do it." (Ward2011) (p216)		
A sense of body awareness, mental clarity, and positive coping. (U)	"It makes you aware of all the parts of your body in a sense…When I just exercised before, I didn't think about how it all connects, and so there's that feeling that it's all connected in some way" (Cheung2022) (p33)	Yoga was appreciated as a beneficial coping strategy for arthritis.	
An improved sense of well-being. (U)	"There is no question that these sessions have improved my sense of well-being, my psychological, my sociological, all of them." (Park 2011) (p323)		
Mind-body benefits. (U)	"It just made me feel better, more flexible, calmer inside, stronger…It helps my mood, outlook and energy." (Greysen2017) (p490)		
Beneficial for balance, posture, strength, breathing, stress, and sleeping patterns. (U)	"I might get a feeling of calmness, and balance. Obviously stretching. Ah breathing is great for me cause I need that, and learning to centre your thoughts." (Ward2011) (p217)		
Inner discipline. (U)	"I definitely feel improvement with less pain, less stiffness. I eat better, I sleep better, my focus is much better, more disciplined for the things that I need to stay healthy for my RA.'' (Greysen2017) (p490)		
Yoga benefits. (U)	"Yoga helps relaxation and improves balance…It's a stress reliever…it helps you cope and clear your mind." (Cheung2022) (p6)		

Building coping skills. (U)	"It tuned me into coping, it tuned into my mind in how I deal with situations…I had to help myself which she taught me to do." (Cartwright2020) (p24)		
A coping tool for mental aspects of RA. (U)	''It helps mentally with acceptance that you have a disease, allowing it to be a part of your life. ..somebody with debilitating disease, we are kind of messed up mentally…it does something to your head and makes you feel weak and small...yoga changes the way you think about your RA." (Greysen2017) (p491)		
Yoga helped cope with the negative emotions associated with RA. (U)	"I think the breathing and the meditation are a big part…it's just, when you have RA you can get a lot of negative thinking and this really helps with that…yoga is really helpful, like a tool to turn to." (Greysen2017) (p490)		
Yoga provided a skill-based coping strategy for the patients, which contributed to their sense of confidence and self-efficacy. (U)	"I learned that even if the joint hurts, even if my hips hurt, I can still do different poses, I can still relax them even if they're hurting, I can do different things with my hips." (Evans2011) (p7)		
Yoga provided an enhanced ability to relax and the time to be peaceful, away from stressors, and daily hassles. (U)	"I really enjoyed it. I found it to be really relaxing and prior to this particular experience, I never knew how to relax. I've never had that moment of pure quiet, like a quiet mind because I live in my head. It was		

	nice to find something that actually got me that quiet in my own head." (Evans2011) (p5)		
Yoga was a tool for relaxation. (U)	"Not just my knees, I feel I am more positive about things when I do yoga. The meditation and breathing help me relax." (Cheung 2015) (p21)		
Yoga gave a different outlook on life and pain. (U)	"I felt like I found this inner peace within me. I found a side of myself that I didn't know I had before…You let go of everything when you're there doing yoga…I forgot about the pain sometimes." (Evans2011) (p7)	Practising yoga changed the way people with arthritis viewed their condition, allowing them to rediscover themselves and regain a sense of normalcy in their lives.	
A sense of enlightenment. (U)	"felt like I was not a yoga person and now I can see anybody can be a yoga person." (Evans2011) (p6)		
Rediscovery: 'I've got my life back' (U)	"I feel my normal self. And I've been going out with friends and family now. We're going to, this one's having a party, birthday party, 60th party, I'm gone. Before, no I can't make it, I can't, I'm too tired and but now it's like I've got my life back in a sense." (Cartwright2020) (p3)		
Yoga routine/habit. (U)	"Every morning, class 5 days a week…" (Cheung2022) (p6)	Consistent yoga practice was perceived essential for achieving long-term holistic benefits for arthritis.	
Increased yoga adherence. (U)	"Yoga is one of the things I've increased at home on my own." (Cheung2022) (p32)		

Participants realized that to experience ongoing benefits, they would need to continue. (U)	“I think I need to stick with practicing yoga on a regular basis to improve symptoms long-term.” (Evans2010) (p911)		

Synthesised finding 4: Categories, findings, and illustrations.

Finding and credibility assigned	Illustration, study author, and page number	Category	**Yoga, arthritis, and session accessibility and structure:** Engagement with yoga practice was influenced by individually determined factors affecting access to sessions, as well as by the structural characteristics of the sessions.
Time. (U)	"I don’t do a lot of yoga because of time restraints." (Cheung2022) (p7)	Juggling with logistical challenges to attending yoga sessions discouraged yoga practice.	
Time. (U)	“So I would prefer to even do it on the way home, or late afternoon, or, you know, almost at some part of my working day…” (Ward2011) (p217)		
Cost. (U)	"…a lot of people with rheumatoid arthritis are on invalid benefits and things like		

	that, and that often, even though if they're not paying out other things for their health, it's often a barrier because there's, you know, living costs and that; you don't get that much, you know." (Ward2011) (p215)		
Cost. (U)	"I would try it more if they offered it as a part of your health plan membership.'' (Greysen2017) (p490)		
Caregiver responsibilities. (U)	"My disabled daughter continues to [need]a great deal…my husband got prostate cancer…" (Cheung2022) (p7)		
Barrier – class difficulty. (U)	"It was really hard to bend my joints, I felt like it wasn't for me or people with arthritis." (Greysen2017) (p490)	Unsatisfactory yoga experiences, including the difficulty level of the practices and discomfort, hindered yoga practice.	
Talking to the yoga therapist in therapy sessions was not useful or appropriate. (U)	"It gave me so much stress…[The therapist] was trying to find out, like you know like something like, something in my life which has caused this thing" (Cartwright2020) (p10)		
Programme structure. (U)	"Yoga is noncompetitive and	Yoga's adaptability and well-paced	

	accepting. It offers modifications." (Cheung2022) (p6)	sessions to suit people's needs and preferences in arthritis were perceived to be helpful.	
Benefits – 'Yoga meets you where you are''. (U)	"I wasn't overwhelmed, so I wasn't like, 'oh my gosh, this is too hard for me, I can't go back,' so, it was just my right pace." (Greysen2017) (p490)		
Benefits – non-invasive, non-pharmacological. (U)	"…it looks pretty non-invasive, so it looks like it shouldn't be too many problems." (Ward2011) (p215)		
Benefits – Adaptable – postures, breathing, relaxation. (U)	"…say I had a flare-up and I went along, I'd probably say, can I sit in a chair and just do breathing exercises." (Ward2011) (p215)		
Personally tailored practice: 'a different kind of yoga'. (U)	"Tailored the routine to suit me and how my health was at that time. If I couldn't do something because of a certain movement then we'd take that bit out." (Cartwright2020) (p23)		
Yoga taught with the support of tools and tailored modifications seemed to bypass physical limitations and participants could be more forgiving.(U)	"I learned to accept my body and not just stay at home in bed if I'm in pain." (Evans2011) (p7)		

Participants made it clear that having a 'textbook' knowledge of RA was not enough in a teacher – they also wanted someone who could empathize with what it was like to live with a chronic illness. (U)	"But for the person to have an understanding and knowledge…and empathy and to know, gosh, this person's got a problem with that joint; this is the alternative way of getting the same effect with this exercise" (Ward2011) (p218)	Availability of a yoga provider with positive qualities, knowledge, and professional training facilitated yoga practice.	
Developing trust in the teacher would enable them to overcome the fear that many of them experienced as an outcome of their current RA management. (U)	"…the fear can be, you know, a problem. But as long as you trust the person that's actually teaching you, that, you know, they've got your well-being, best interests." (Ward2011) (p218)		
Programme instructions. (U)	"Having an instructor that understands and is concerned about your joints really helped." (Cheung2022) (p6)		
Participants were appreciative of the careful selection of therapeutic sequences and the inclusion of modifications and teachers trained to work with students with health needs. (U)	"It just seemed different because…somehow with the regular yoga, it seems like it's all about 'Look, how strong I am; look at these interesting positions I can make my body into.' Whereas this seemed		

	more like they actually cared about your health and how to make you feel better, and you know, let's try and get you into a position that's going to help you and relax you at the same time, which seemed a lot more pleasant." (Evans2011) (p5)		
Props and resources. (U)	"I stretch my legs, my arms, whole body, I cannot balance but I grab a chair." (Middleton) (p86)	The provision of props and resources was perceived to offer confidence and security for yoga practice.	
Sense of security of having a chair. (U)	"I don't think I could do the yoga unless I had something beside me to help me. The chair yoga offers security for me." (Park 2011) (p323)		
Resources as a potential facilitator. (U)	"…something that would really work for me and probably would keep me going would be something like a DVD that I could do at home on a daily basis." (Ward2011) (p216)		
Props as a potential facilitator. (U)	"They would need to supply, like, a bench to lie on and chairs to sit on and things like		

	that." (Ward2011) (p216)		
Props and resources. (U)	"Standing on the toes holding the wall, it is pretty good. I did the warm up looking at the book." (Middleton2017) (p86)		

Synthesised finding 5: Categories, findings, and illustrations.

Finding and credibility assigned	Illustration, study author, and page number	Category	**Yoga, arthritis, and the session environment:** A supportive social environment in yoga sessions, characterised by a welcoming space and meaningful connections, encouraged yoga practice in people with arthritis.
Yoga provided a space where no one judged their ability to perform the yoga practice and where participants gained social support from people who understood their condition. (U)	"…they're not going to go [laugh], eww, you know, what's wrong with you? You know, they already know what's wrong with ya…" (Ward2011) (p218)	Safe and supportive space (in group sessions) and a "therapeutic" space (in one-to-one sessions) were considered important for yoga practice.	
A tailor-made yoga intervention for people with RA gave them the courage to attempt yoga. (U)	"I feel like it'll be more of a safe environment being that it's a study for arthritis and everyone in the class may have some issues." (Evans2011) (p4)		
The therapeutic function of the	"It was a bit like a counselling		

consultation: ‘like counselling’. (U)	session...where we would find triggers as to what is going on in my life, in my mind that would have a negative impact on my health, so pinpointing those areas and working on that, I feel has had a massive difference.” (Cartwright2020) (p23)		
Family/social support. (U)	“Do it with people…if you have a companion to exercise you’re more motivated.” (Cheung2022) (p6)	Social connectedness in a group setting was perceived as a strong motivation for yoga practice.	
Group: Commonality, applicability, adaptability/social support. (U)	“I just would be more motivated if it was with other people I knew, sort of understood how I felt, or, you know, like, yeah, I just want, wanna feel more comfortable with, even if they are strangers that they’ve got the same illness and stuff.” (Ward2011) (p215)		
Social. (U)	“Yoga was amazing to me, how much strength and energy you build up and there’s a social aspect of it…we’ve developed pretty good friendships there.”		

	(Greysen 2017) (p491)		
Motivator-being influenced by others. (U)	“A group of friends here at work had talked about doing Bikram yoga, and there was a deal, so I tried it.” (Greysen2017) (p490)		
Social/emotional support. (U)	“Today I did standing poses, my son did them too, and he was also helping me by telling me how. Then I felt that gradually, the stretches are rather easy to do." (Middleton2017) (p86) (RA)		

Appendix 8: Participant information sheet

PARTICIPANT INFORMATION SHEET

Research Ethics Reference: FMHS

40-0722 Version 1.1

Date: 18/01/2023

We would like to invite you to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read this carefully and discuss it with others if you wish. Please contact us to ask us anything that is not clear.

1. What is the purpose of the research?

Arthritis has tremendous physical and psychological health and social and economic consequences. Currently, approximately 10 million people in the UK have some form of arthritis, the most common one being osteoarthritis. This imposes a huge economic burden of around 5 billion pounds every year, on the National Health Service (NHS). The NHS suggests yoga as a safe and beneficial practice for people with arthritis. However, despite yoga's increasing popularity and potential benefits for arthritis, there is little research exploring yoga providers' experiences and perceptions of delivering yoga sessions that include people with arthritis. To

recommend yoga to people with arthritis, it is important to understand what yoga providers know about the condition, what positive or negative experiences they have had in delivering yoga to people with arthritis, how they perceive their role in helping people to manage their arthritis and what further training they may need. This study aims to answer these questions.

2. Why have I been invited to take part?

You have been invited to take part in this research because you have expressed an interest in participating and you are eligible if you meet the following inclusion criteria:

- You are a yoga teacher/therapist (aged 18 years or above)
- You are based in the UK
- You are able and willing to provide written informed consent
- You have delivered yoga sessions at least once a fortnight during the last six months, to individuals aged 18 years or older in the UK.

3. Do I have to take part?

It is up to you to decide if you want to take part in this research. We will describe the study and go through this information sheet with you to answer any questions you may have. If you agree to participate, we will ask you to sign a

consent form and will give you a copy to keep. However, you would still be free to withdraw from the study at any time, without giving a reason; simply let the research team know.

4. What will happen to me if I take part?

You will be asked to attend an interview at the date, time and mode (online or telephonic or face-to-face) that suits you best. We will only interview you once. If you prefer an online interview, MS Teams will be used. If you prefer an in-person interview, a quiet public place will be chosen. The interview will last for about 30-45 minutes. All the interviews will be conducted by the lead researcher (IB) and with your consent, the conversation will be audio recorded. Field notes will also be taken to complement interviews in terms of nonverbal cues that may not be adequately captured through the audio-recording. You will be informed that there are no right, or wrong answers and you can express your views freely. The interviews will be conducted following an interview guide. We will also ask you to complete a short questionnaire to provide us with some background information about yourself including age group, gender, and other background information like yoga training, the kind of yoga sessions you provide and for how long have you been providing them, description of yoga sessions and languages used to deliver

these sessions. This data collection will align with university policy and adhere to regulations given by the university. Essential study requirements include thoroughly reading this document, providing written consent on the appropriate form, providing verbal consent before the start of the interview and completing the questionnaire. Interviews will be audio recorded, on MS Teams if interviews are conducted online and on an audio recording device, for face-to-face interviews or telephonic interviews. Some of the interview data will be transcribed (written out word by word) by the lead researcher to understand the data and the remaining data transcription will be completed using the University of Nottingham automated transcription service. All the information will be anonymised and checked for accuracy by the researcher. Source documents including but not limited to, field notes, consent forms, interview transcripts and audio recordings will be stored in OneDrive- a facility provided by the University for storing and protecting data, by the researcher. They will be treated as confidential documents and access to the information will be limited with password protection to the researchers and any relevant regulatory authorities. Once you express your interest to participate in the research, you will be provided with this participant information sheet through email. Then, if needed, you can contact the researcher through email to go through the information sheet and get an

explanation about the procedures before participating. You will then be asked if you have any further questions about the study or any other information on the participant information sheet before the interview. If you agree to take part in the study, you will be asked to attend a single interview, online or telephonic or face-to-face according to your preference. After reading through this participant information sheet, if you are still happy to take part, then you will be asked to electronically sign a consent form and send us back via email, before attending the interview. Upon arrival for the interview, we will give you a chance to ask any questions and ask for your verbal consent, before starting the interview.

5. What is semi-structured interview?

Semi-structured interviews enable the researcher to collect open-ended data i.e., the knowledge, experiences and perceptions of the participant and to get deep insights on the topic using an interview guide. A conversational and informal approach is maintained during the interview by the interviewer instead of a routine question-answer interview approach. The interviewer will actively listen to the participant without any judgement or biases and encourage conversation. Further if it is a face-to-face interview or video interview (online), there is opportunity to observe social and

non-verbal communication or cues of the participant. These cues facilitate the interviewer to explore the insights of the participant better.

6. Are there any risks in taking part?

We do not anticipate any risks in taking part in this study because the topic is not sensitive, difficult or upsetting. One possible risk is that you may disclose personal information and the researcher will ensure that anonymity is maintained during the interview by not using your name and removing any personal identifiers when transcribing the audio recording of the interview.

7. Are there any benefits in taking part?

There will be no direct benefit to you from taking part in this research, but your contribution may help in achieving the aims of our research. The findings may give us an understanding of the benefits of yoga for people with arthritis which can be of use in the future. Also, you will be given an online shopping voucher as a thank you for giving up your time.

8. Will my time/travel costs be reimbursed?

You will receive as an inconvenience allowance to participate in the study (an online shopping voucher). Travel expenses

will not be offered for any visits incurred as a result of participation.

9. What happens to the data provided?

Research data will include field notes, consent forms, interview transcripts and audio recordings. Personal data (e.g., age group, gender and other background information) will be collected from you through a questionnaire. This data collection will align with university policy and adhere to regulations given by the university. Each interview is likely to last for 30-45 minutes. The research data will be stored confidentially in OneDrive by the researcher. The study records will collect only the minimum information required for the study and will be kept with all personal identifiers or other recognisable information removed. Your contact details will be kept separately from all other data and will be retained only if you provide consent for the contact details to be retained. Personal/sensitive data will be treated as confidential documents, and access to the information will be limited to the researchers and any relevant regulatory authorities. Computer-held data will be held securely and password-protected; only known by the researcher. Upon completion of the study, research data will be archived for a minimum of 7 years in the University of Nottingham data repository held on a secure cloud-based data storage drive. We would like your

permission to use fully anonymised direct quotes in research publications. We would also like to share our research data (e.g., in online databases) with other researchers in other Universities and organisations both inside and outside the European Union, if you provide specific consent for us to do this. This would be used for research in health and social care. Sharing research data is important to allow peer scrutiny, re-use (and therefore avoiding duplication of research) and to understand the bigger picture in particular areas of research. All personal information that could identify you will be removed or changed before information is shared with other researchers or results are made public.

10. What will happen if I don't want to carry on with the study?

Even after you have signed the consent form, you are free to withdraw from the study at any time without giving any reason. If you withdraw from the study, we will no longer collect any information about you or from you, but we will keep the anonymous research data that has already been collected and stored. This information may have already been used in some analyses and may still be used in the final study analyses. Any personal data will be destroyed.

11. Who will know that I am taking part in this research?

The only people who will know that you are taking part in the study are the researcher and the researchers' supervisory team. No one else will be informed that you are taking part, including your GP or any other health professional. Your data will be completely anonymised for analysis and in all presentations of research findings. Data will be used for research purposes only and in accordance with the General Data Protection Regulations. Under UK Data Protection laws the University is the Data Controller (legally responsible for the data security) and the Chief Investigator of this study (named above) is the Data Custodian (manages access to the data). You can find out more about how we use your personal information and read our privacy notice at: https://www.nottingham.ac.uk/utilities/privacy.aspx/.

Designated individuals of the University of Nottingham may be given access to data for monitoring and/or audit of the study to ensure we are complying with guidelines.

12. What will happen to the results of the research?

The research will be written up as a thesis for the degree of Doctor of Philosophy (PhD) in Epidemiology and Public Health. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be

published open access. The results of the research may also be disseminated through a publication in a medical journal.

13. Who has reviewed this study?

All research involving people is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. The University Ethics committee has approved this study.

14. Who is organising and funding the research?

This research is being organised by the supervisors Dr Kaushik Chattopadhyay and Prof Sarah Lewis at the University of Nottingham and is being funded by the University of Nottingham.

15. What if there is a problem?

If you have a concern about any aspect of this project, please speak to the researcher, Ms Isha Biswas or the Principal Investigator, Dr Kaushik Chattopadhyay, who will do their best to answer your query. The researcher will seek to understand your concern and give you an indication of how he/she intend to deal with it. If you remain unhappy and wish to complain formally, you can do this by contacting the FMHS Research Ethics Committee Administrator, Faculty Hub, Medicine and Health Sciences, E41, E Floor, Medical

School, Queen's Medical Centre Campus, Nottingham University Hospitals, Nottingham, NG7 2UH or via Email: FMHS- ResearchEthics@nottingham.ac.uk. Please quote ref no: FMHS 40-0722.

16. Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Ms Isha Biswas

Lifespan and Population Health Academic

Unit, School of Medicine,

Clinical Sciences Building,

Nottingham City Hospital,

Hucknall Road, Nottingham

NG5 1PB

Email: isha.biswas@nottingham.ac.uk

Appendix 9: Consent form

Participants

Consent Form Final

version 1.1:

18.01.2023

Title of Study: Knowledge, experiences and perceptions of yoga providers on the management of arthritis among adults in the UK: a qualitative study

REC ref: FMHS 40-0722

Name of Researcher: Lead researcher: Ms Isha Biswas

Supervisors: Dr Kaushik Chattopadhyay and Prof Sarah

Lewis Name of Participant:

1. I confirm that I have read and understand the information sheet version number 1.1 dated 18.01.2023 for the above study which is attached and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without disadvantage.

3. I understand that relevant sections of my data collected in the study may be looked at by the research group and by other responsible individuals for monitoring and audit purposes. I give permission for these individuals to have access to these records and to collect, store, analyse and publish information obtained from my participation in this study. I understand that my personal details will be kept confidential.

4. I understand that the interview will be audio recorded using an automated transcription service and that anonymous direct quotes from the interview may be used in the study reports.

5. I understand that information about me recorded during the study will be made anonymous before it is stored in a secure database. Data will be kept for a minimum of 7 years after the study has ended and then deleted.

6. I agree to take part in the above study.

7. Optional: I agree that my anonymous research data will be stored and used to support other research during and after 7 years and shared with other researchers including those working outside the University.

8. Optional: I agree to my contact details being stored for the purpose of being invited to participate in future research studies.

Name of Participant Date Signature

_Isha Biswas_____ _____ _____

Name of Person taking consent Date Signature

_____

Appendix 10: Interview guide for the qualitative study

Introduction

- Hello! Thank you for agreeing to participate in the interview. I am Isha Biswas from the University of Nottingham.

- I am interviewing you to explore the knowledge, experiences, and perceptions of yoga providers in the UK have on the management of arthritis among adults. I would like to assure you that our purpose is not to test your yoga teaching skills but just to get an overview of the management of arthritis in yoga classes in the UK.

- Participation is voluntary and you have been invited to this interview as you have sent me a written consent to participate in this research through email. Before I start the interview, I would like to ask if you have read the participant information sheet? Do you have any questions?

- The interview should take 30-45 minutes approximately. With your permission, I would like to record the interview. However, I would like to assure you that all data relating to you will be kept strictly confidential. The recording of this interview and any quotes used in the study report will not identify you in any way. Please feel free to ask any questions about what I have just explained. May I now start recording?

Background

- How would you describe your gender?
- What is your age group? (18-24 years, 25-44 years, 45-64 years, 65 years or more)
- Can you tell me about your yoga training background/yoga education level?
- For how long have you been providing yoga sessions (in the UK)?
- Please provide the name(s) of the place(s) in the UK where you deliver/have delivered yoga sessions.
- In which settings do you provide yoga to your yoga students?

(Yoga classes, yoga workshops, at yoga students' homes or outdoors)

- What kind of yoga sessions do you conduct? (one-on-one, small groups, large groups)
- Please tell me what does one of your typical yoga sessions looks like? (Emphasis on each component such as yogic poses, breathing practices, meditation and relaxation practices, others (please specify))
- What languages do you use while delivering yoga sessions?

- Please tell me something about yourself and how and when did your yoga journey start?

1. Do your yoga students talk to you about their health conditions/diseases? If no, move on to question 2.

 If yes, what health conditions/diseases do they have and have disclosed to you about?

Have any of them disclosed to you about having arthritis?

 If yes, in a month, how many of your students on an average mention having arthritis?

2. What do you know about arthritis?

Are you aware there are different types of arthritis?

If no, move to question 3.

 If yes, can you tell me anything about the different types of arthritis?

 Do you know anything about the causes of each of the types?

3. What do you know about the management of arthritis in the NHS?

- What are the limitations for the management of arthritis in the NHS?

- How do you think yoga, as a component of the management of arthritis, might be beneficial? (Any particular aspects of yoga)

- Are there any particular types of yoga that might be beneficial for osteoarthritis of specific joints? (e.g., knee, hip, wrist). Please describe.

- Are there any particular types of yoga that might be beneficial for rheumatoid arthritis of specific joints? (knee, hip, wrist). Please describe.

4. Do you have any experience of delivering yoga to people with arthritis?

If yes,

- How confident do you feel in teaching yoga to yoga students with arthritis?

- If you lack confidence in teaching yoga to yoga students with arthritis, what do you think that you lack confidence in? (e.g., inadequate yoga training etc)

5. How do you modify the content of the yoga sessions and how you deliver them, depending on the type of arthritis?

- Similarly, how do you modify the content of the yoga sessions and how you deliver them, depending on the affected joint?

6. Do you feel that you have a role to help people manage arthritis through yoga? If yes,

- How important do you think your role is?

If no, move on to next question.

7. What factors, do you think, encourage people with arthritis to join yoga practice? (Reduced pain, improved function, convenient timings of yoga sessions, moderate costs etc)

8. What do you think are the challenges of delivering yoga to people with arthritis? (e.g., cost issues, timings, language barrier, issues with yoga poses, injuries etc).

9. Have you had any training to deliver yoga to people with arthritis during your yoga education?

- Do you think further training would be helpful in terms of delivering yoga to people with osteoarthritis and rheumatoid arthritis?
- If yes, please describe the kind of support or training needs that you would need. (e.g., specific changes in protocols to make delivery of yoga more effective, use of specific props and materials)?

- What kind of special training is required, depending on the affected joint and the type of arthritis, to deliver yoga to people?
- Have you had any training in how to modify sessions for people with arthritis? Please describe.
- If no, what sort of training might be required?

10. Do you think the yoga students perceive yoga as a self-management option for arthritis?

If yes,

- Do the yoga students mention to you any change in their health outcomes related to arthritis after yoga practice? (e.g., reduced pain, improved function, any other (please specify))
- If yes, what are the reasons do you think, encourage yoga students with arthritis to practice yoga? (increased flexibility, reduced pain, better sleep, overall health benefits etc)
- If no, do yoga students with arthritis have any particular concerns when they are practising yoga? (e.g., thinking that yoga would take too much of their time, cost, inconvenient postures, injuries, expenses etc)

Conclusion

- We have now reached the end of the interview.

- I would like to inform you that an online shopping voucher will be provided to you soon.
- Please feel free to ask any questions about this study.
- I would like to reiterate that all the information that you provided will be confidential and anonymous.
- Thank you very much for your time and the information that you shared today.

Appendix 11: Ethical approval

University of Nottingham
UK | CHINA | MALAYSIA

Faculty of Medicine & Health Sciences
Research Ethics Committee
Faculty Hub
Room E41, E Floor, Medical School
Queen's Medical Centre Campus
Nottingham University Hospitals
Nottingham, NG7 2UH
Email: FMHS-ResearchEthics@nottingham.ac.uk

22 August 2022

Isha Biswas
PhD Student in Epidemiology and Public Health
Lifespan and Population Sciences
Clinical Sciences Building
City Hospital Nottingham Campus
Nottingham University Hospitals
Hucknall Road
Nottingham
NG5 1PB

Dear Ms Biswas

Ethics Reference No: FMHS 40-0722 **– please always quote**	
Study Title: Qualitative study on arthritis	
Chief Academic/Supervisors: Kaushik Chattopadhyay, Associate Professor in Evidence based Healthcare, Sarah Lewis, Professor of Medical Statistics, Epidemiology and Public Health, Lifespan and Population Sciences, School of Medicine	
Lead Investigators/student: Isha Biswas, PhD student Epidemiology and Public Health	
Proposed Start Date: 01/11/2022	**Proposed End Date:** 31/10/2023

Thank you for submitting the above application which was considered by a sub-committee meeting on 20 July 2022 and the following documents were received:

- FMHS REC Application form and supporting documents version 1.0: 30.06.2022

These have been reviewed and are satisfactory and the study is given a favourable research ethics opinion.

A favourable research ethics opinion is given on the understanding that:

1. Gatekeeper permissions from the major Yoga Associations in the UK are in place and copies submitted to the Committee for the record.
2. The protocol agreed is followed and the Committee is informed of any changes using a notice of amendment form (please request a form).
3. The Chair is informed of any serious or unexpected event.
4. An End of Project Progress Report is completed and returned when the study has finished (Please request a form).

Yours sincerely

pp Lomiggiani

Bethan E Phillips, Professor of Translational Physiology, School of Medicine
Centre Of Metabolism, Ageing & Physiology (COMAP) Injury, Inflammation & Recovery Sciences
Acting Chair, Faculty of Medicine & Health Sciences Research Ethics Committee