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Yoga for Arthritis: A Scoping Review

Steffany Haaz, PhD^a and Susan J. Bartlett, PhD^{b,c}

^aJohns Hopkins School of Public Health, Baltimore, MD

^bDepartment of Medicine, McGill University, Montreal, Ontario

^cJohns Hopkins Division of Rheumatology, Baltimore, MD

Synopsis

The aim of this article was to systematically review the existing literature on the use of yoga for persons with arthritis. We included peer-reviewed research from clinical trials (published from 1980-2010) that used yoga as an intervention for arthritis patients and reported quantitative findings. Eleven studies were identified, including four RCTs and four NRCTs. All trials were small and control groups varied. No adverse events were reported and attrition was comparable or better than typical for exercise interventions. Evidence was strongest for reduction in disease symptoms (tender/swollen joints, pain) and disability, as well as improved self-efficacy and mental health. Interventions, research methods and disease diagnoses were heterogeneous. Larger, rigorous RCTs are necessary to more effectively quantify the effects of yoga for arthritic populations

Keywords

yoga; rheumatoid arthritis; osteoarthritis; physical activity; exercise; mindfulness

Introduction

Yoga includes a variety of theories and practices that originated in ancient India and have evolved and spread throughout the world. In Sanskrit, yoga means “to yoke” or connect ¹. This typically refers to mind-body integration, but over the thousands of years that yoga has evolved, this focus has also been applied to spatial surroundings, nature, other individuals and spiritual interconnectedness ². The physical practice of yoga, referred to as “hatha,” was originally intended to prepare for meditation, an important spiritual practice in many cultures. In recent decades, hatha yoga has become popular for physical activity and stress management. Other aspects of yoga, including study of ancient texts, dietary practices, acts of service, and moral living may be mentioned, but are not generally a focus of western classes.

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Corresponding author for proof and reprints: Steffany Haaz, PhD, Johns Hopkins Arthritis Center, 5200 Eastern Avenue, Mason F. Lord, Center Tower, 4th Floor, Baltimore, MD 21224, (410) 550-5216, shaaz@jhsph.edu.

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After attention to posture, deep breathing and/or chanting, yoga practice often begins with a slow movement sequence to increase blood flow and warm muscles. This is followed by poses that include flexion, extension, adduction, abduction and rotation^{1;3}. Holding poses builds strength by engaging muscles in isometric contraction^{4;5}. Moving joints through their full range of motion increases flexibility^{6;7}, while standing poses promote balance by strengthening stabilizing muscles and improving proprioception to reduce falls^{8;9}. Thus, yoga incorporates several elements of exercise that may be beneficial for arthritis.

To cope with pain, arthritis patients often reduce activity^{10;11}. However, inactivity can result in muscle or tendon shortening, articular capsule contraction and weakened ligaments¹². Conversely, regular activity may decrease pain and preserve stability^{13;14}.

While there was once concern that exercise might increase inflammation and exacerbate pain, regular physical activity is now recommended as part of comprehensive treatment of arthritis¹⁵⁻¹⁸. The American College of Rheumatology (ACR)¹⁹, Osteoarthritis Research Society International (OARSI)²⁰ and the Ottawa Panel²¹ note that stretching, strengthening and conditioning exercises can preserve physical function, increase strength and improve endurance for people with arthritis. All persons with arthritis should consult with their doctor to determine a safe and appropriate approach to increasing physical activity

Unfortunately, long term exercise maintenance is uncommon even for healthy individuals, generally approaching 50% after six months²². Vigorous exercise is ideal for physical health²³ and may be acceptable for some persons with arthritis^{24;25}, but could be intolerable and may not be recommended for those with significant joint instability or damage^{26;27}. Adherence to moderate intensity exercise is more broadly tolerable, but still not attained by the majority of those with arthritis²⁸. For arthritis patients, emphasis on stretching and strength, posture, balance and the ability to adjust pace and intensity are important components of a safe activity, all of which yoga encompasses. Yoga is multifaceted, including focused breathing, mental engagement, stress management, social connection and/or meditative concentration along with physical activity. Yoga may offer an alternative to traditional exercise and potential psychological benefits or increased enjoyment for enhanced exercise adherence. Yoga could, therefore, provide another way for arthritis patients to be active and engaged in health-promoting behavior. Mind-body interventions such as yoga that teach stress management with physical activity may affect diseases from multiple fronts and may be well-suited for investigation in both OA and inflammatory immune-mediated diseases such as RA.

The goal of this review is to evaluate existing evidence regarding the effects of yoga practice on clinical, functional and psychosocial outcomes for people with arthritis.

Methods

Databases including MEDLINE, PsychLIT, PsychINFO and IndMed (an Indian database) were searched from 1980 through May 2010 for research trials that used yoga (including poses, breathing practices, relaxation and/or meditation) as an exercise intervention for arthritis patients. Additional relevant publications found in references from the original search list were also reviewed. Research in progress was searched via abstracts from annual scientific meetings of the American Public Health Association, American College of Rheumatology, Osteoarthritis Research Society International, European League Against Rheumatism and the International Association of Yoga Therapists. The following search terms were used: yoga OR yogic AND arthritis, arthritic, rheumatoid, rheumatic OR osteoarthritis. This review was limited to studies including quantitative statistical analysis and peer-review.

Results

A total of 11 articles that described evaluating the effects of a yoga intervention in persons with arthritis were examined. One case series was excluded for lack of quantitative methods²⁹. Final analysis consisted of ten studies. (Table 1.) Five studies focused on RA, two were for OA only, and two included both RA and OA or arthritis in general. The studies were all published from 1980 to 2010.

Study Quality

Study quality was assessed based on: study design, sample size, intervention protocol and statistical analysis. Studies were classified as low, moderate or high for each. These criteria are based on categories set forth by the US Department of Health and Human Services in their 2002 report, "Systems to Rate the Strength of Scientific Evidence"³⁰. Funding source was not included as a category, since the majority of studies did not report a funding source, although the available information about funding is described. Since this review includes both randomized and observational trials, categories were adapted for both types. (Table 2).

Study Design

Of the ten studies that were included in this review, four were RCTs³¹⁻³⁴, two compared people with arthritis to healthy controls, matching for age and sex^{35;36}, two utilized a non-randomized control (NRCT)^{37;38}, and two were cohort studies^{39;40}. Three of the RCTs had a waitlist control and the other two were usual care. The NRCTs assigned participants to control if they were unable to attend the first class session. None had an active control group. Six studies were reported as journal articles^{31;35;37-40}, one was a letter-to-the-editor (LTE)³⁴ and three were presented as abstracts at annual research meetings^{32;33}. One was presented as an abstract at an annual meeting, followed by publication in a journal that did not include a process of peer-review³⁶; therefore, only the abstract was included in this review.

Sample Size

Sample sizes ranged from three²⁹ to 26³⁷ intervention completers, with similar comparator group numbers. Only one study had as many as 20 persons per group³⁷. The necessary sample size to provide sufficient power to detect differences between groups was not generally described. Generally, a 10:1 subject to variable item ratio is recommended in multivariable regression analysis to avoid type I errors^{42;43}, although this depends on variable distribution^{44;45}.

Six studies reported on attrition, with rates of 0%³⁷, 9%³⁴, 22%³¹, 36%⁴⁰ and 37%^{36;39}, with the three most rigorous studies having the lowest rates of attrition. The two cohort trials and one with healthy matched controls had the highest rates of attrition. The greatest retention was from the NRCT and two RCTs. Most studies analyzed data for completers only. Only one study reported the consideration of attrition in final analysis, excluding one dropout prior to baseline³⁴. Remaining studies did not report attrition^{32;33;35;41}.

Intervention Protocol

Intervention protocols varied widely. The "dose" of yoga varied substantially between studies, and was often inconsistent within studies. For example, the study with the greatest dose included 120 minutes of practice 5 times per week, followed by once per week for three months with 10-30 minutes of daily home practice. In contrast, the lowest dose included 60 minutes once per week for eight weeks. Yet another study was only 15 days long, but included daily practice in a retreat setting. Some studies required daily home practice, some weekly, and some had no element of home practice. While many protocols

were developed and/or taught by licensed or certified yoga professionals (teachers, therapists or scholars) some did not describe the intervention development or delivery. This is further complicated because requirements and regulation of yoga instruction differ by jurisdiction and culture, and credentials of the yoga professionals are not always standardized. Some studies used a style of yoga with a long history and published texts describing teaching methods and practice, while others developed a new protocol for the population under investigation. Some studies failed to describe the protocol in any detail.

Three studies, an RCT for hand OA ³¹, a cohort study for knee OA ⁴⁰ and a NRCT of young adults with RA ³⁹, used an Iyengar-based yoga (IY) program. This style is known for utilizing props (blocks, straps, bolsters), adjusting to individual anatomy ¹. The program for both OA studies was developed by one of the authors who is a senior certified yoga instructor, and the RA protocol was devised by an “experienced IY teacher” ³⁹. The hand OA trial included 10 weeks of “stretching and strengthening exercises emphasizing extension and alignment, group discussion, supportive encouragement and general questions and answers” ³¹. Poses emphasized respiration and upper body alignment. The protocol is described generally with reference to a previous publication. The knee OA study described a 15 pose series and prop modifications, which could be easily replicated. The RA study by Evans et al listed examples of poses ³⁹. The IY-based programs were 6 ⁴⁰, 8 ³¹ and 10 ³¹ weeks, meeting once or twice weekly for 60-90 minutes.

An NRCT for RA used a program developed by the authors in consultation with rheumatologists and a certified yoga therapist. This program, conducted by Badsha et al included “stretches, strengthening, meditation and deep breathing” in 6-weeks of biweekly classes ³⁷. A healthy matched-control study by Dash and Telles included poses, breathing practices, meditation, lectures and “joint loosening exercises” in a 14-day yoga training camp ³⁵. The RCT by Haslock and Ellis ³⁴ used gentle tailored poses, breath control, meditation, lectures and discussions with intention to soften emotions. For the first 3 weeks, 120-minute sessions were held 5 days per week, followed by weekly 120 minute sessions for 3 months.

Abstracts from an RCT of RA and OA used a gentle yoga program developed by rheumatologists, psychologists and a registered yoga therapist ^{32;33}, incorporating poses, breathing practices, relaxation, meditation, chanting and supplemental reading. An age- and sex-matched control study taught a Social-Cognitive Theory-based Kundalini Yoga intervention to those “having been diagnosed with arthritis” ³⁶. Kundalini Yoga emphasizes the spine, with a focus on raising energy and awareness ⁴⁶. The study included poses, breathing techniques, meditation and relaxation. In two studies ^{34;40}, the reader is referred elsewhere for description of the practice.

Data Collection and Analysis

Well-validated instruments were administered by blinded assessors in 6 studies ^{29;31;34;35;40;41}. These included anatomical changes, biomarkers, performance outcomes, and clinical assessment. Only one study used unmasked assessors, noting this as its greatest limitation ³⁷.

All but two studies ^{34;36} measured baseline variables and outcomes recommended by ACR or OARSI ^{47;48}. None used “sham yoga” to blind participants. Consequently, all self-report data suffers from possible expectation bias. However, the chosen self-report instruments are commonly used for persons with arthritis and known for strong psychometric properties.

One study with healthy controls created a new assessment tool to measure intervention efficacy and participant perceptions ³⁶. The authors had previously used some of the

questions in this population and demonstrated strong validity and reliability. Additions to the tool were checked for face and content validity by three academics.

Only two trials (a NRCT and cohort study) reported efforts to ensure that data characteristics supported the methods (such as assuming a normal distribution), and adjusted the statistical plan as necessary ^{37;40}. Eight articles/abstracts described hypotheses up front and linked outcomes to those hypotheses. The other two listed feasibility as their primary outcome ^{34;36}. However, some outcomes were not well-explained in the study's context. For example, a study comparing RA patients to healthy controls hypothesized that yoga would result in increased strength ³⁵. However, this study measured pre- and post-intervention NSAID dose, without assessing analgesic or other medication use and included no pain measures.

Overall Study Quality

Of 8 possible points, studies ranged from 3-6 in overall study quality (Table 3). Future expansion from pilot studies and abstracts may include greater rigor. While available information is limited, the strongest studies can point toward associations that may be confirmed with additional trials.

Study Findings

Professional organizations have provided evidence-based recommendations for the use of particular outcomes for RA and OA. ACR suggests that trials of RA use the following measurement tools: tender joint count, swollen joint count, patient pain assessment, patient and physician global assessment of disease activity, patient assessment of physical function, laboratory evaluation of one acute phase reactant ⁴⁷. For OA, OARSI recommends pain as the primary outcome, along with physical function and a patient global assessment ⁴⁸. These can be measured with any tool that has adequate validity, reliability and responsiveness. They do not rule out the later addition of other outcomes, such as physician global assessment, HRQL, inflammation, stiffness, and time to surgery. While no study included all of the recommended outcomes, most included one or more. See Table 4 for study findings.

Clinical Outcomes

The Disease Activity Score (DAS) is an index developed to measure RA disease activity that has been extensively validated for use in clinical trials ^{49;50}. It includes the number of tender and swollen joints along with the erythrocyte sedimentation rate or C-reactive protein and a patient assessment of disease activity. Two RA studies measured DAS-28 (which includes a 28 joint count) and both found statistically significant improvements for patients participating in the yoga intervention as compared to controls ^{33;37}.

Two studies measured ring size as a marker of hand inflammation. Haslock and Ellis reported a trend toward statistical difference in ring size for persons with RA ³⁴, while Garfinkel et al saw no change in ring size in persons with hand OA ³¹. A difference in anti-inflammatory medications for persons with RA could not be attributed to the intervention since the two groups differed at baseline ³⁵.

Only one knee OA study reported on stiffness, but found no improvement ⁴⁰, although they did report a trend toward improvement for global patient assessment. The hand OA trial saw improved finger tenderness and finger range of motion ⁵¹ and a study of general arthritis (diagnostic inclusion criteria unclear) used their own symptom self-report instrument with no improvements demonstrated ³⁶.

Functional Ability

Several studies assessed strength, balance, flexibility and/or mobility. Three used hand grip, which has been considered a clinical measure of general strength⁵², hand function, pain, disease activity⁵³ and future disability⁵⁴. Improvements were found for two RA studies^{34;35}, but not in hand OA³¹. A NRCT of post-menopausal women with RA showed improved balance³⁸, while the knee OA pilot found no change in 50 ft walk time⁴⁰.

Four of the five studies in RA used the Health Assessment Questionnaire (HAQ), a self-report of disability status, as an outcome measure. Two found significant improvement compared to controls or baseline^{37;38} and another showed a trend toward improvement³⁴. The HAQ also includes a visual analog scale (VAS) of pain, which was used in three of the RA studies. Two demonstrated significant improvement^{38;39}, while one found no change³⁷. Although the HAQ is often considered to be a disease-specific instrument intended for use in RA, it has also been used more broadly and was included in a study for persons with hand OA³¹. In this study, there was no change in the functional dimension of the HAQ, but pain by VAS did improve significantly; however, the HAQ is not as sensitive to changes in persons with OA⁵¹.

Psychosocial Outcomes

The Arthritis Impact Measurement Scale 2 (AIMS2) and the Medical Outcomes Study Short Form-36 (SF-36) assess HRQL. The SF-36 is a general measure⁵⁵ while the AIMS2 is specifically designed for arthritis patients⁵⁶. Both contain mental and physical domains. The AIMS2 addresses unique issues of this population, but the SF-36 allows for comparison with non-arthritic participants.

Significant improvement in AIMS2 affect was seen for knee OA, with a trend toward improved symptoms and patient global assessment. Using the SF-36, one study found no improvements³⁷, while an abstract reported improved emotional roles and energy with a trend toward improved mental health³².

Improvements in psychosocial health were captured using other instruments, including the Beck Depression Index³⁸. Two RA studies saw no changes in psychological health, measured by the General Health Questionnaire³⁴ and SF-36³⁷. Changes in cortisol levels, a common biomarker of psychological stress, was also measured with significant improvement in daytime measurements, and a trend for improved diurnal and awakening levels³⁸. Measures of pain included the Western Ontario and McMaster Osteoarthritis Index (WOMAC), a validated index for OA of the knee and hip, for a study of OA⁴⁰ and the Pain Disability Index (PDI) for a study of RA³⁸. Improvements in pain were statistically significant in both studies³⁹. Persons with arthritis who practiced Kundalini yoga reported increased self-efficacy and frequency of yoga behaviors³⁶.

Medication Use

Two studies required that no changes were made to treatment during the trial^{34;40} and one RA study required stable dose of DMARDs and a limit to glucocorticoid use³⁸. Badsha et al. reported medication reductions for three persons with RA in the yoga group (3 corticosteroids, 1 etanercept, 2 methotrexate) “as a result of clinical improvement” and none in the control group³⁷. Dash and Telles noted a statistically significant reduction in NSAID use for the intervention group of persons with RA, though groups differed at baseline³⁵. Other studies did not report changes in medication or procedures to maintain stable medication use.

Funding Sources

Most articles and abstracts did not disclose whether the study was funded. The study by Badsha et al. was funded by the Emirates Arthritis Foundation and by an unrestricted grant from Abbott Pharmaceuticals with no reported conflicts of interest³⁷. Research by Kolasinki et al was partially supported by American College of Rheumatology Clinical Summer Preceptorship Program⁴⁰. The LTE from Haslock and Ellis notes in acknowledgements that “Marks and Spencer contributed to the cost of data processing”³⁴. No other mention is made of funding support.

Discussion

The assessment of yoga for arthritis is in its infancy. In general, the studies that are reported in the literature are very small in both size and scope. The use of recommended outcomes and validated measures was typical, but only a few outcomes were included in each study. Therefore, there is too little overlap in disease state and measured variables to pool data or draw preliminary conclusions.

HRQL is an important self-reported outcome that can inform about broad effects of interventions on several life domains. Few studies included HRQL, and none used it as a primary outcome. While instruments like the HAQ and WOMAC measure arthritis disability and its impact on daily activities, they do not assess eight domains of health, ranging from physical limitations to energy and mental health. Additionally, because they are primarily used in arthritis populations, this does not allow for comparison with health adults or other chronic conditions.

Study designs varied and each has drawbacks, including lack of masking, lack of control groups, group crossover, and biased group assignment. In these cases, limitations were often noted, but efforts made to reduce bias were not always explained. No study administered comparison treatment arms. This would strengthen findings, but requires a larger sample size and greater resources, which is a challenge in time-intensive, behavioral research trials³¹.

‘Yoga’ describes a range of practices. While most studies described a comprehensive intervention (poses, breathing, relaxation and/or meditation), the styles, doses and format varied. Researchers must be clear about the delivered intervention, and that it is population appropriate. Determining which aspects of the practice are safe and beneficial can only follow when it is known what has been tested. Especially with patients who have considerable musculoskeletal limitations and symptoms, what is taught and how it is modified should be detailed in future research and practice. Beyond this, researchers should provide protocol transparency so that larger, more rigorous trials can replicate the interventions utilizing the same methods to confirm or dispute findings. Furthermore, when design methods and statistical analyses are not well-described, research cannot be properly evaluated and readers are unable to determine whether methodological flaws may be responsible for error in findings.

For classroom-based interventions, it may be challenging to recruit participants willing to travel and dedicate several hours per week for months, especially with unpredictable, painful diseases. Understudied interventions are often limited to the safest and healthiest (by age and/or disease status) to first ensure no harm before expanding to vulnerable populations. This reduces qualifying participants, particularly for a rarer disease (such as RA). However, this can bias the sample and limit generalizability to all persons with the disease.

Arthritis encompasses many diagnoses. The two most common, OA and RA, have significant pathophysiologic differences, and effects of an intervention such as yoga may not be the same for each. Moreover, the effects of yoga on isolated hand versus knee OA may also have significantly different outcomes. Combining persons with different diseases in the same intervention and analyzing the data collectively could mask an effect that is strong for just a portion of participants, or could suggest a universal effect that only applies to a subgroup with one particular form of arthritis. The use of biomarkers as treatment outcomes will improve current understanding of how additional biochemical and pathophysiological parameters of diseases respond to interventions.

The research in this review was conducted in diverse populations across the globe, which suggests broad interest, as well as cross-cultural acceptance. However, perceptions of yoga, teaching methods and differences in arthritis treatment are likely to influence intervention effects and, possibly, results in different findings.

Overall, the most consistent findings were for tender orswollen joints in persons with RA, which improved for all three studies that used this outcome. Another common outcome was pain, which improved in six out of eight studies, measured by various instruments. Disability improved in three out of four studies. Self-efficacy improved in both studies for which it was measured. Mental health and energy improved for two out of three studies. For grip strength, improvements were seen in both studies of RA, but not the study of OA that included it. Results for global health and physical functioning were inconsistent. Measures of disease symptoms and physical functioning were more commonly used than markers of physical fitness or psychosocial functioning. Because different instruments were often used to assess the same outcome, interpretation of results across studies is compromised.

A goal of future studies should be to create standardized protocols that are optimized to enhance safety, enjoyment and long-term adherence (including specific poses and modifications). Studies have varied considerably with regard to the frequency and duration of yoga practice, as well as the style and specific class content. Authors need to thoroughly describing the practice studied, including specifying the yoga lineage (Iyengar, Kundalini, etc.) in the methods section or separately publishing intervention details.

Interdisciplinary collaboration in the design of yoga interventions is appropriate for this population. Yoga experts, rheumatology clinicians or clinical researchers alone are not equipped to create an authentic and appropriate yoga program without consultation with each other. Such a program requires careful attention to the stress on joints and connective tissue, as well as the consideration of joint range of motion and adaptation during potential disease flares. An arthritis-appropriate program that has been created in careful collaboration and well-tested through rigorous research methods is required as a next step in the evolution of this research.

It would be of significant interest to study the mechanisms by which yoga affects arthritis symptoms. The use of standardized outcome measures and appropriate statistical methods are essential for confirming findings. The field awaits large, comprehensive trials that may validate improvements indicated by this collection of small pilot studies.

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Table 1

Studies included in systematic review

Title	Authors	Design	Journal	Date Published	Participants	Sample Size	Location	Intervention
ARTICLE								
Iyengar yoga for treating symptoms of osteoarthritis of the knees: a pilot study	Kolasinski et al	Cohort	The Journal of Alternative and Complementary Medicine, Vol. 1(4), 689-693	2005	Knee OA in at least one knee, 6/7 obese, >50 years of age, all female	7	Philadelphia, PA	90 min, 1/wk, 8 wks (Iyengar)
Evaluation of a yoga-based regimen for treatment of osteoarthritis of the hands	Garfinkel et al	RCT, waitlist control	Journal of Rheumatology 1994;21:2341-3	1994	Hand OA, ages 52-79, male and female	17	Philadelphia, PA	60 min, 1/wk, 8 wks (Iyengar)
Improvement in hand grip strength in normal volunteers and rheumatoid arthritis patients following yoga training	Dash and Telles	Matched controls for age, sex	Indian Journal of Physiology and Pharmacology 2001; 45(3):355-360	2001	RA, ages 21-43, male and female	40		15 continuous days
Functional and physiological effects of yoga in women with rheumatoid arthritis: a pilot study	Bosch et al	Convenience control	Alternative Therapies	2009	RA, post-menopausal women	16		90 min, 3/wk, 10 wks
The benefits of yoga for rheumatoid arthritis: results of a preliminary, structured 8-week program	Badsha et al	Convenience control	Rheumatology International	2009	Middle-aged adults with RA, mostly of Indian and Caucasian descent	47	Dubai, UAE	60 min, 2/wk for 6wks (Raj)
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Measuring the effects of yoga in rheumatoid arthritis	Haslock et al.	RCT, usual care control	British Journal of Rheumatology 1994;33:787-792	1994	RA, ages 15-72	20	Britain	120 min 5/wk for 3wks, 1/wk for 3 mo, 10-30 min daily home practice
Iyengar yoga for young adults with rheumatoid arthritis: results from a mixed methods pilot study	Evans et al.	Cohort	Journal of Pain and Symptom Management 2010; 39(5): 904-913	2010	RA, young adults	5	Los Angeles, CA	90 min, 2/wk, 6 wks

ABSTRACTS

Title	Authors	Design	Journal	Date Published	Participants	Sample Size	Location	Intervention
Initial Findings of an RCT of Yoga on Physical and Psychological Functioning in RA and OA	Haaz	RCT, waitlist control	American College of Rheumatology	2007	RA or knee OA, age 18-65, mostly female, mixed racial background	37	Baltimore, MD	60 min, 3/wk, 8 wks, 1/wk home practice
The Effect of Yoga on Clinical Parameters in Patients with Rheumatoid Arthritis	Haaz	RCT, waitlist control	American College of Rheumatology	2008	RA, age 18-65, mostly female, mixed racial background	30	Baltimore, MD	60 min, 3/wk, 8 wks, 1/wk home practice
Testing a yoga-based behavioral intervention as a complementary therapy for arthritis	Sharma	Matched controls for age, sex	American Public Health Association	2004	Any arthritis diagnosis, age 45-66, mostly women, all Caucasian	24	Midwestern state, USA	75 min 1/wk, 6 wks (Kundalini)

Table 2

Study quality scoring, based on HHS recommendations

Study Quality Score	0	1	2
Study design	Uncontrolled	Matched or convenience control, such as comparing pre-existing groups	Randomized, controlled trial
Sample size (final data set)	0-10 per group	11-20 per group	>20 per group
Intervention	Lacking detailed description about the intervention's components and protocol	Comprehensive yoga program with mention of several components (ie. poses, breathing, meditation)	Well described comprehensive program, including specific poses and/or modifications, images, class structure, etc.
Data Analysis	Justification for outcome measures not described or not validated, unnecessary potential for bias, statistical methods not appropriate for the data.	Some limitations in collection and analysis of data that are generally recognized and explained by study authors.	Hypothesis-driven outcomes, reliable and validated measures with efforts to reduce measurement bias and explanation for use of appropriate statistical methods

Table 3

Outcome of Study Quality Assessment, based on criteria in Table 2

Authors	Study Design	Sample Size	Intervention	Data Collection/Analysis	Overall
Kolasinski et al (2005)	0	0	2	2	4
Garfinkel et al (1994)	2	1	2	1	6
Haslock et al (1994)	2	1	2	1	6
Dash and Telles (2001)	1	1	1	1	4
Sharma (2005)	0	1	1	1	3
Badsha et al (2009)	1	2	2	1	6
Haaz (2007/8)	2	1	1	1	5
Boschl (2003)	2	0	1	1	4
Evans et al (2009)	0	0	1	1	2

Table 4

Study Findings

Authors	Study Quality	Clinical Outcomes	Functional Outcomes	Psychosocial Outcomes
Kolasinski et al	4	Improved: WOMAC pain, function Trend: GA No change: Stiffness	No change: 50 ft. walk	Improved: Affect
Garfinkel et al	6	Improved: finger tenderness, hand pain, ROM No change: hand function, ring size	No change: grip strength	
Haslock et al	6	Trend: HAQ-DI, ring size	Improved: Grip strength	No change: GHQ
Dash and Telles	4		Improved: Grip strength	
Sharma	3			Improved: Self efficacy for yoga
Badsha et al	6	Improved: HAQ-DI, DAS-28 No change: HAQ Pain		No change: physical/mental QOL
Haaz	5	Improved: tender/swollen joints		Improved: physical & emotional roles, energy (RA), pain (RA) Trend: Mental health, energy (OA), pain (OA)
Bosch	4	Improved: HAQ-DI and Pain	Improved: Balance	Improved: Depressive symptoms, daytime cortisol Trend: diurnal, awakening cortisol
Evans	2	Improved: pain (PDI, HAQ) Trend: physical functioning No change: HAQ-DI		Improved: vitality, mental health, global severity, self-efficacy Trend: chronic pain acceptance, mindfulness