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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In a 70-year-old woman with knee osteoarthritis (knee OA), is a yoga-based exercise program more effective for improving function and decreasing pain than a standard exercise program? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| The patient is a 70-year-old woman who has struggled with knee OA (left side more symptomatic than right) for several years. The pain has led to decreases in her activity and participation, which has contributed to further weight gain, loss of lower extremity strength, balance deficits, psychological distress, and an overall loss of functional mobility. Her radiographs indicate cartilage loss and joint space narrowing, which has contributed to her fear-avoidance behaviour, as she does not want to exacerbate her issue. She participates in an aquatic exercise program twice per week, which provides temporary relief but has not contributed to substantial improvements on land. This patient wishes to find an exercise program that is safe for individuals with OA, and will help decrease her pain and improve her knee function so she can participate in the activities she loves. She has never taken yoga before, as she did not know it could be beneficial for osteoarthritis, and is intimidated by the portrayal of yoga in the media. She also does not enjoy strength training, and most weight-bearing aerobic exercises tend to increase her pain. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| Eight studies were appraised that met the inclusion/exclusion criteria, including seven randomized controlled trials (RCTs), and one quasi-experimental study. Many of these articles were pilot studies with small sample sizes.   * Several studies compared a yoga program to an exercise program (aerobic and/or strengthening) or educational intervention, as well as to a control group over an eight-12 week period. Several studies only included a yoga intervention group, and did not include a control group and/or a comparator. * All studies included only participants with knee OA, and several of the studies included only older female participants. Several studies looked specifically at the impacts of yoga for obese and/or sedentary individuals with knee OA. * All studies included outcome measures to assess changes in response to yoga, including levels of pain, strength and range of motion, physical performance, as well as self-reported measures of balance efficacy, health-related quality of life, and depression/anxiety. * Yoga was found to be a safe exercise program for all individuals. In all included studies, yoga led to significant improvements in at least one relevant outcome measure. Yoga was found to be more beneficial than traditional exercise in some regards (e.g. less knee pain and greater reported physical function)1, but at least equally beneficial for most outcomes of interest. * High quality evidence exists, but more studies are required with a greater duration and larger sample size to assess the long-term efficacy of this lifestyle intervention as compared to more conventional treatment options. |

**CLINICAL BOTTOM LINE**

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| Yoga is a safe intervention for older women with knee OA, and may help improve functional mobility and decrease pain, perhaps to a greater degree than the current gold standard treatment of aerobic and strengthening exercises. The movements associated with yoga may improve synovial fluid distribution within joints, increase muscle strength to support arthritic joints, improve balance, and stretch tight soft tissues.5 Yoga also emphasizes a mind-body connection, which can help with awareness of joint position and alignment (proprioception). Yoga may also affect the perception of pain more effectively than traditional exercise, as meditation/mindfulness may help chronic pain sufferers “detach” from their pain through self-awareness and coping strategies.1 Yoga is a person-centered approach, as it emphasizes self-empowerment and self-efficacy. However, the use of yoga in clinical practice should be based on patient preference. Some individuals may prefer a strengthening or aerobic training program to address their symptoms rather than yoga, which can also be safe and effective. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

*The above information should fit onto the first page of your CAT*

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** | | | |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Knee pain  Knee arthritis  Knee osteoarthritis  Osteoarthritis of the knee  Arthritis of the knee  Knee OA  Knee degenerative joint disease | Yoga program  Yoga  Yoga-based program  Yoga-based exercise program  Yoga exercise program  Hatha yoga | Traditional exercise program  Strengthening  Aerobic exercise  Conventional exercise program  Exercise  Physical therapy  Physiotherapy  Standard physical therapy  Standard physiotherapy | Pain  Patient-reported function  Functional mobility  WOMAC  Quality of life |

**Final search strategy (history):**

*Show your final search strategy (full history) from PubMed. Indicate which “line” you chose as the final search strategy.*

1. Knee osteoarthritis OR knee arthritis OR knee OA
2. Yoga
3. Yoga-based program
4. Hatha yoga
5. Physiotherap\*
6. Physical therap\*
7. Exercise
8. Pain
9. Function\*
10. WOMAC
11. #1 AND (#2 OR #3 OR #4) AND (#5 OR #6 OR #7) AND (#8 OR #9 OR #10)
12. **#1 AND (#2 OR #3 OR #4) AND (#5 OR #6 OR #7)**

*In the table below, show how many results you got from your search from each database you searched.*

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed**  **Cochrane**  **Embase** | **32**  **26**  **80** | **10: Included only clinical trials**  **25: Included only clinical trials**  **40: Included only “controlled study”, “randomized controlled trial”, “randomized controlled trial (topic)”, “clinical trial”** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| -Randomized controlled trials  -Patients have clear diagnostic criteria of knee osteoarthritis  -The intervention for the experimental group is yoga  -Yoga program included aspects of breathing, mindfulness, meditation, and/or relaxation  -Outcome included functional limitation and/or pain measure |
| **Exclusion Criteria** |
| -Studies not published in English  -Poster presentations  -Published as conference processing  -Subjects had a knee arthroplasty on the affected side  -Patients non-ambulatory |

**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**

*For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).*

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| **Author (Year)** | **Risk of bias (quality score)\*** | **Level of Evidence\*\*** | **Relevance** | **Study design** |
| **Cheung et al. (2017)** | **Jadad Scale: 4** | **Level 1b (not a systematic review)** | **High** | **Pilot RCT** |
| **Kuntz et al. (2018)** | **Jadad Scale: 4** | **Level 1b (not a systematic review)** | **High** | **RCT** |
| **Ebnezar et al. (2012)** | **Jadad Scale: 4** | **Level 1b (not a systematic review)** | **High** | **RCT** |
| **Kolasinski et al. (2005)** | **Jadad Scale:**  **1** | **Level IIIB (did not perfectly match Portney & Watkins table, but the quasi-experimental design without a control group decreases the level of evidence)** | **Moderate** | **Quasi-Experimental Pilot Study** |
| **Deepeshwar et al. (2018)** | **Jadad Scale:**  **4** | **Level IB (not a systematic review)** | **Moderate** | **RCT** |
| **Park et al. (2017)** | **Jadad Scale: 4** | **Level 1B (not a systematic review)** | **Moderate** | **Pilot RCT** |
| **Cheung et al. (2014)** | **Jadad Scale:**  **4** | **Level 1B (not a systematic review)** | **Moderate** | **Pilot RCT** |
| **Moonaz et al.** | **Jadad Scale:**  **4** | **Level IB (not a systematic review)** | **Moderate** | **Pragmatic RCT** |

\*Indicate tool name and score

\*\*Use Portney & Watkins Table 16.1 (2009); if downgraded, indicate reason why

**BEST EVIDENCE**

The following 2 studies were identified as the ‘best’ evidence and selected for critical appraisal. Rationale for selecting these studies were:

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| * Managing knee osteoarthritis (OA) with yoga or aerobic/strengthening exercise programs in older adults: a pilot randomized controlled trial. (Cheung et al. 2017). This RCT has a high level of evidence, as it underwent a stringent randomization process, and the investigator and biostatistician were blinded. It compares hatha yoga, aerobic/strengthening exercise, and an educational intervention on various aspects of knee OA management. The participants were mainly female with an average age of 71.6. The research demonstrates the benefits yoga may have over traditional exercise for lower extremity physical function, fear of falling, and anxiety. * Efficacy of a biomechanically-based yoga exercise program in knee osteoarthritis: A randomized controlled trial. (Kuntz et al. 2018). This RCT demonstrates a high level of evidence, as they performed a stringent randomization process, and the investigator and assessors were blinded. Exercise instructors and participants were also blinded to the hypothesis of the study. The participants had an average age of 66.7 and were all female. This study compared a biomechanically-based yoga program, the traditional gold-standard exercise program, and a no-exercise control group for individuals with knee OA. The results demonstrated that the benefits of yoga are comparable and perhaps superior in some ways to traditional exercise in the management of the physically debilitating symptoms of knee OA. |

**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of (Managing knee osteoarthritis (OA) with yoga or aerobic/strengthening exercise programs in older adults: a pilot randomized controlled trial) by (Cheung et al., 2017)**

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| **Aim/Objective of the Study/Systematic Review:** |
| To compare the therapeutic effects of a eight-week Hatha yoga program to a traditional aerobic/strengthening exercise program for adults aged 60 and older with symptomatic knee OA. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * Pilot RCT * Parallel design with three arms: Hatha yoga (HY), aerobics and strengthening exercises (ASE), and education control group. Participants were randomized into these groups using an online software randomization program. The group assignment was given to each participant in an envelope by the principal investigator following baseline data collection by a blinded research assistant. * At baseline, information regarding health status and demographics was collected for all participants. Standardized outcome measures validated for use in older populations with OA were administered at baseline, four, and eight weeks. * ANOVA was used to analyse group differences at baseline. To assess response to interventions, data were analysed using SAS by a biostatistician who was blinded to group assignment, with statistical significance indicated by a p value of < 0.05. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| Intervention was located in a large metropolitan area in the Upper Midwest. The HY and ASE groups participated in in-person classes at a building with ample parking, whereas the control group received brochures and weekly phone calls. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * This study included a purposive sample of participants, who were recruited at various OA-related events at senior & community centers, as well as through flyers and newsletters. * Participants must have had a self-reported diagnosis of symptomatic knee OA for six months or greater, be a community dwelling adults of at least 60 years of age, not practiced yoga for the last two months, and not currently participating in a supervised exercise program more than twice per week. Participants were not included if their joint locking affected their balance to the degree that exercise was unsafe, relied on assistive devices, had a knee surgery within the last two years (or ever had a knee replacement), recently received corticosteroid or hyaluronic acid injections (within three and six months, respectively), or had self-reported comorbidities that could affect symptoms. A second wave of recruitment due to increases in funding included women only, as this was the primary focus of the research. * Potential participants were screened by a research assistant on the phone, and then invited for an in-person second-step screen if eligible. * The participants were generally Caucasian, well-educated older females. For those that completed the study (n = 83), the average age was 71.6, average body mass index (BMI) was 29.0, and the sample was 84% female. * The HY group (n = 32) had the following characteristics at baseline: average age (68.9), BMI (29.8). The ASE group (n = 28) had the following characteristics at baseline: average age (74.4), BMI (29.2).  The education control (n = 23) had the following characteristics at baseline: average age (71.8), BMI (27.8). * At baseline, OA pain level, age, and fear of falling were statistically different. The uneven group sizes were due to issues with the funding period as well as to avoid having classes during extreme winter weather. * There were four dropouts in the HY group, five in the ASE group, and one in the control group, leaving 83 people available for follow-up. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| The control group (n = 23) received educational brochures from the Arthritis Foundation. These brochures contained information regarding how to manage pain from OA, as well as exercise recommendations for knee OA. The members of the control group also received weekly phone calls from the research assistant, who inquired about health status and OA symptoms. To incentivize the control group, they were promised a free yoga for OA session after the completion of the study. |
| *Experimental* |
| HY group:  The yoga classes were designed by a group of experienced yoga teachers, and taught by a registered yoga teacher with experience working with older adults with functional mobility limitations. The program consisted of one weekly 45-minute class for eight weeks, as well as a 30-minute at home practice four times per week throughout the duration of the study. Approximately eight-ten poses were included during each class, with several new poses introduced each time. Many of the poses included stretching and strengthening of the hip and knee muscles, such as the quadriceps and hamstrings. The classes included poses in sitting, standing, prone, and supine. The classes were progressive in intensity, and included modifications if necessary such as blocks, straps, and chairs. Breathing exercises, mindfulness, and relaxation techniques were also included in each class.  ASE group: The exercise program consisted of eight weekly classes, which included 15 minutes of an aerobic warm up, as well as 30 minutes of isometric and isotonic strengthening exercises. At home, the participants were asked to complete the aerobic exercises for 15-30 minutes four times each week, and the strengthening exercises for 30 minutes twice per week. The exercise program was progressive in intensity throughout the eight-week period. It was taught by a certified arthritis exercise instructor, and based on current recommendations from the Arthritis Foundation for knee OA.  Subjects in both groups participated in small classes (n<11), received the necessary equipment (yoga mat, elastic band, etc.), and a HEP handout with pictures and written instructions. |
| **Outcome Measures**  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| All outcome measures were assessed at baseline, four weeks, and eight weeks by a trained research assistant in-person.  Primary Outcome Measures:   * OA symptoms, including pain, physical function, and stiffness, were measured using the Western Ontario and McMaster Universities OA Index Scale (WOMAC). This tool uses a five-point Likert scale, in which zero indicates no symptoms and four indicates the most severe symptoms. The possible score range for pain is 0-20, 0-8 for stiffness, and 0-68 for physical function. Combined, the minimum possible score is 0 (asymptomatic), and the maximum possible score is 96 (highly symptomatic). * Pain was also assessed with the Visual Analogue Scale (VAS), with a minimum score of 0 and a maximum score of 10. * Subjects also reported the average number of medications for pain that they used on a daily basis for their knee OA.   Secondary Outcome Measures:   * Physical performance was measured using the Short Physical Performance Battery (SPPB), which includes repeated chair stands, a balance test, and a timed eight-foot walk. For each of these three sections, there is a maximum score of four, and a minimum score of zero, with higher scores indicating greater physical function. Therefore, the combined maximum score is 12, and the minimum score is zero. Gait speed was also measured using the 50-foot walk test. * Mood disturbance such as anxiety and depression were assessed with the Hospital Anxiety and Depression Scale (HADS). This self-report scale includes seven items regarding anxiety and seven regarding depression. The maximum score is 21, and the minimum score is zero (higher numbers indicate greater anxiety and/or depression). * Fear of falling was assessed with the Falls Efficacy Scale International (FES-I). This 16-item self-report scale can be used to determine concerns about falling during a variety of functional activities. The minimum score is 16, and the maximum score is 64, with higher scores indicating greater fear of falling. * Spiritual health was measured using the Self-Transcendence (SF) scale, which examines coping strategies, self-awareness, and self-boundaries. The maximum score is 60, and the minimum score is 15, with greater scores indicating greater spiritual health. * Quality of life was measured with the Short Form Health Survey (SF-12), which contains both physical and mental components. This is a useful tool to determine role limitations as a result of both emotional and physical health factors. Scores range from 0-100, with 50 as the mean, and greater scores indicating better physical and/or mental health. * At the end of the eight weeks, program satisfaction was assessed using a Likert scale, with one indicating that participant would not recommend the program, and four indicating they would “definitely” recommend the program. * Adherence to the program was also measured using the class attendance record, exercise logs, and home practice recordings. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.] |
| Primary Outcomes Measures:   * At eight weeks, the HY group had greater improvements in symptoms as compared to the ASE group based on the WOMAC (WOMAC total: −9.6 [95% CI −15.3, −4.0]; *p* = .001). The HY group had less knee pain on this subsection on the WOMAC (WOMAC pain index scores: −1.4 [95% CI −2.7, −0.1]; *p* = .04), as well as the VAS (−1.1 [95% CI −2.2, −0.1]; *p* = .03). Additionally, the HY group reported higher perceived function (WOMAC function index scores: −7.6 [95% CI 11.9, −3.3]; *p* =.001) * Comparing the HY group to the education control group, similar results were found. The HY group experienced a significantly greater improvement in knee OA symptoms (WOMAC total: −9.5 [95% CI −15.5, −3.5]; *p* = .002), specifically pain (WOMAC pain index scores: −1.5 [95% CI −2.9, −0.0]; *p* = .05), Visual Pain Analog scores: (−1.2 [95% CI −2.2, −0.1]; *p* = .03) as well as perceived physical function (WOMAC function index scores: −7.1 [95% CI −11.6, −2.5]; *p* = .003).   Secondary Outcome Measures:   * Compared to the control group, the HY group took significantly less time to complete chair stands (.5 [95% CI .1, 1.0]; *p* = .03), and significantly less time to walk eight feet on the SPPB (−.5 sec [95% CI −1.0, 0.0]; *p* = .04). * Additionally, the members of the HY group had significantly decreased anxiety (−1.4 [95% CI −2.7, 0]; *p* = .04) as compared to the ASE group, and significantly decreased fear of falling as compared to the ASE group (−4.6 [95% CI −7.5, −1.7]; *p* =.002) and the control group (−3.8 [95% CI −6.9, −.7]; *p* = .02) at the end of the intervention.   No other statistically significant differences were found between groups at the end of the study, including adherence and program satisfaction. |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| An aerobic/strengthening exercise program is the current gold standard for people with knee OA, as ASE has been shown to reduce disability and pain for these individuals. However, the results of this study indicate a Hatha yoga intervention program may be just as effective for the treatment of this disease, and even more effective for decreasing pain and improving self-reported physical function. Additionally, the HY group also had greater improvements in strength, and greater decreases in anxiety and fear of falling as compared to the ASE and control group. Yoga encourages safe movement with proper alignment, active and passive joint motion, strengthening of lower extremity muscles, and challenges balance. These factors can strengthen the knee joint, stretch tight soft tissues, and reduce avoidant behaviour due to fears of falling or damaging an arthritic joint. Additionally, the meditative aspects of yoga may help people decrease their reactivity to chronic pain, as yoga emphasizes self-awareness, relaxation, and stress reduction. This may help individuals cope with their pain more effectively, and become more in tune with their mind’s relationship to their body. ASE is similarly effective for improving strength, range of motion, coordination, and balance, but yoga is the clear winner when it comes to pain, self-reported physical function, and secondary psychological ramifications of this chronic disease. HY may also be safer than ASE, which is a concern for individuals with health conditions such as OA. Three participants in the ASE group had possible exercise-related injuries during the study, whereas none of the yoga participants had any adverse events. Yoga is a gentle approach, which may be ideal for this functionally limited population. |
| **Critical Appraisal** |
| **Validity**  [Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| Internal validity:  This study has a high level of evidence, as it is an RCT that utilized a stringent randomization and blinding procedure. It should be noted that the principle investigator and biostatistician were blinded to group selection, but as this was an exercise intervention, the participants and research assistant were aware of group selection. The subjects were representative of the population of interest, as they were older females with symptomatic knee OA. However, the recruitment process is questionable, as the OA was “self-reported”, rather than a medical diagnosis. The research assistant was apparently “trained”, but the study lacks details about what his qualifications are. The changes in the outcomes of interest seem to be caused by the independent variables (intervention group), as there did not appear to be any major confounding variables at play. Retention was acceptable, as it was 82%. This high retention rate could likely be due to factors that the participants all had in common, such as high motivation. This could be a threat to internal validity, as shared characteristics among self-selected subjects can create bias. Overall, the internal validity of this study is acceptable.  External Validity:  This study uses reasonable inclusion and exclusion criteria that help improve the generalizability of the results. Although this type of study is replicable, the authors do not provide much detail regarding the interventions. They simple list a few of the postures and exercises included, but do not mention the intensity, progressions, etc. The small sample size and inconsistent group sizes threaten the external validity of this study. The authors note that this was not ideal, as the funding period for the study was unexpectedly short, and severe winter weather affected the program. The differences at baseline between the groups may have been due to the small, inconsistent sample sizes. Although the randomization process likely alleviated selection bias, the imbalance in baseline characteristics still limits external validity. The demographic characteristics of the sample may also contribute to selection bias, as the program consisted of self-selected, Caucasian, well-educated women who are likely more motivated than the typical adult with knee OA. This reduces the generalizability of the findings to the rest of the population and leads to volunteer bias. Overall, this study had some issues with external validity. Many of these issues would be mitigated with a larger sample size, with more diversity in demographic and educational factors. |
| **Interpretation of Results**  [This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| The results of this study are highly indicative of the benefits of yoga for individuals with knee OA. Yoga is a safe, gentle treatment approach, that can improve strength, range of motion, balance, mind-body connection, as well as psychological symptoms associated with OA such as fear of falling, depression, anxiety, and poor coping strategies. Yoga has similar benefits to ASE when it comes to physical performance, but yoga is likely more beneficial for improving pain levels, self-reported physical function, balance self-efficacy, and anxiety.  The WOMAC is an outcome measure commonly used by physical therapists to assess knee pain and disability. The HY group’s baseline WOMAC score was 39.4/96, which is considered an “intermediate” baseline score.9 The minimally clinically important difference (MCID) with good response to rehabilitation was -7.9, meaning that a decrease in WOMAC score of 7.9 or greater is indicative of a substantial improvement in a patient’s life.9 Following the eight-week yoga intervention, the HY group’s WOMAC score decreased by 13.0 (26.4). This is a huge improvement, as it is almost twice the MCID, and even greater than the MCID after a total knee replacement (TKR), which 11.5 after six and 12 months (although some sources report that the MCID after a TKR is 15).9 The WOMAC score for the ASE group decreased from 42.1 to 36.0, which is 6.1 points. This is a very important finding, as joint replacements have many risks, and are extremely expensive. Yoga may be a safe and effective way for individuals with OA to manage their symptoms and avoid surgery.  Although this study is convincing regarding these findings, there are many limitations that should be noted. As described previously, the sample sizes were small, and lacked similarities at baseline. All participants were self-selected, and were generally highly-educated females, which can lead to inherent biases and threats to generalizability. The study was also only eight weeks long, which is barely enough time for strength adaptations to occur, let alone changes to a holistic lifestyle intervention such as yoga. The researchers should recommend that the participants continue their yoga programs, and routinely follow up to assess long-term adherence and efficacy. Additionally, it would have been beneficial to include a licensed clinician such as a physical therapist to help with the recruitment process, exercise instruction, and outcome measure administration. The study fails to indicate what “training” the research assistant received, which may impact the results of the study. And lastly, the details regarding the ASE intervention are dubious. The exercises listed do not necessarily relate to the knee joint (e.g. shoulder circles, torso twists, side bends, etc.). Although the authors mention that elastic bands were used during the classes, none of these exercises seem to be truly strength-building. It is possible that the classes lacked the intensity to produce physiological changes. It would be helpful for the authors to include parameters of the various exercises, such as repetitions, sets, intensity, etc. |
| **Applicability of Study Results**  [Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| This study has high applicability to my clinical question and scenario. My patient is of the same age, gender, race, and educational background as the majority of the participants. The results of the study address her concerns perfectly, as she has been looking for a safe and effective way to decrease her pain and improve her function. However, in applying these findings to the general population, there are many factors that must be considered. Starting to practice yoga as an elderly person with functional limitations requires a gentle and modified approach. It may be necessary to find a yoga instructor, yoga therapist, or physical therapist with experience in the use of therapeutic yoga for older adults with OA to ensure safety and effectiveness. Additionally, yoga studios can be extremely expensive, so home practice should be encouraged if possible. Depending on patient preference, physical therapists should incorporate yoga techniques into self-care strategies and therapeutic exercise, such as focusing on alignment, balance, mind-body awareness, interesting “flowing” sequences that incorporate knee joint motion and strength, awareness of breath, meditation, and mindfulness. These strategies may encourage a patient to begin their own yoga practice, which will ultimately improve their physical function, pain perception, self-efficacy, coping strategies, and participation in the activities that they enjoy. |

**(2) Description and appraisal of (study title) by (authors, Year)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The purpose of this study was to develop a biomechanically-based yoga exercise program that would not overload osteoarthritic knees, and to compare the effectiveness of this program to traditional exercise in terms of changes in pain, self-reported physical function, and mobility for women with knee OA.  Some common exercises can often exacerbate symptoms of knee OA, and lead to further progression of the disease, especially when skeletal malalignments or faulty movement patterns are at play. An elevated magnitude of knee adduction moment (KAM), which corresponds to the ratio of medial compartment vs total knee joint loading, has been shown to predict disease progression due to the high contact pressures within the medial knee. Repetitive exposures to a high KAM can lead to greater pain severity for individuals with knee OA, so this program seeks to minimize KAM through corrective yoga postures. This study hypothesizes that the mindfulness-based exercise approach used in yoga can help increase awareness of faulty movement patterns that may increase KAM, as well as strengthen muscles and improve mobility, thereby resulting in decreased pain and improved function for individuals with knee OA. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * Three-arm, single-blind, parallel randomized controlled trial * After stratification for disease severity using the Lower Extremity Functional Scale (LEFS), subjects were randomized into one of three groups (two intervention groups and one control group). Randomization was performed with Matlab software and a 1:1:1 allocation ratio. * Group allocation was distributed in a concealed envelope by an investigator who was uninvolved in collection of data. * Data collection was performed by an investigator who was uninvolved in interventions and blinded to group allocation. * Although exercise instructors and subjects were aware of group allocation, they were blinded to the hypothesis of the study (that the yoga group would experience greater improvements than the control group, and equal or greater improvements compared to the exercise group). * Outcome measure administration was performed by the same blinded assessor before and directly after the 12-week intervention period. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| This study was carried out in a community setting in Southwestern Ontario, Canada. Specifically, the trial was conducted at in Hamilton at McMaster University. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * The participants were recruited through PT, orthopaedic, and rheumatology clinics, as well as through newspaper advertisements and through word-of-mouth. * This study included a purposive sample of N = 31 community-dwelling, ambulatory women, all at least 50 years of age (mean age of 66.7 years), and who met the criteria set forth by the American College of Rheumatology for knee OA. Participants were excluded if they had other forms of arthritis, various other knee pathologies, history of knee surgery, history of osteoporotic fracture, unstable cardiovascular conditions, neurological disease, physical-activity restrictions, lower extremity trauma in past three months, pregnancy, ipsilateral hip and/or ankle conditions, and allergies to medical tape. * After stratification for disease severity using the LEFS, participants were randomized into one of three groups, including a yoga exercise (YE) group, a traditional exercise (TE) group, and a no exercise (NE) attention-equivalent control group. * The YE group had the following characteristics at baseline: n = 10, mean age = 65.5 years, mean BMI = 30.1, LEFS = 43.1. The TE group had the following characteristics: n = 11, mean age = 63.7 years, mean BMI = 28.9, LEFS = 41.7. The NE group had the following characteristics: n = 10, mean age = 71.1, BMI = 32.3, LEFS = 41.6. There were no significant differences between in BMI, age, or LEFS scores at baseline between the three groups. * All participants adhered to the program for the entire duration, except for one of the TE participants, who only completed two training sessions and was lost to follow-up (TE n = 10 available for follow-up). Additionally, one participant in the YE group experienced a flare-up of a pre-existing medical condition, so their mobility performance was not included in the analysis (YE n = 9 included in analysis). |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| For all three groups, participants attended three out of the four available one-hour supervised sessions per week for a duration of 12-weeks. For all groups, attendance and program adherence were monitored, and gift bags and stipends were rewarded based on completion and participation.  NE group: The control participated in a guided meditative relaxation class in a group-setting, taught by a certified yoga instructor. These classes were not movement based, and consisted of bodily awareness exercises such as body scans, breathing, and relaxation performed in supported passive postures. |
| *Experimental* |
| The YE and the TE group were asked to maintain their effort levels at a seven out of ten on the Borg Perceived Exertion scale, and to report their knee pain on the VAS before each session to ensure the program did not increase pain by more than two levels.  YE group:  The yoga exercise group was taught by a certified yoga instructor. The classes began with a supine body-awareness exercise, then strengthening exercises, and ended with a supine relaxation exercise. The intensity of the strengthening portion of the class increased gradually over the 12-week period. The classes consisted of lower extremity exercises that emphasized alignment and activation of muscles while maintaining a low KAM. The program consisted of static postures performed while barefoot, and included various forms of squats and lunges. The instructor paid careful attention to the maintenance of ideal alignment of the lower extremities, and provided cues as necessary to the participants.  TE group:  This program was designed based on the current gold-standard strength training for knee OA. It was designed and supervised by physical therapists and kinesiologists, and was performed at a physical activity center. The strengthening exercises were performed using pneumatically-resisted exercise machines, and targeted mainly the quadriceps muscle, but also included every other major muscle group of the lower extremity. The sessions began with a ten-minute aerobic warm-up on a treadmill or cycle ergometer prior to the strength-training, and static stretching and balance exercises were performed following the strength-training. Over the 12-week duration, the intensity of the program increased, including number of sets and the resistance used during the exercises. |
| **Outcome Measures**  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| The outcome measures were administered at the start and the completion of the 12-week study, and were administered at the physical activity center by the same blinded assessor.  Primary Outcomes:   * The Knee Injury and Osteoarthritis Outcome Score (KOOS) and the Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP) were used to assess knee pain. The KOOS measures pain intensity during a variety of activities and movements, and contains nine items rated on a five-point Likert scale. Scores are normalized from 0-100, with lower scores indicating more severe symptoms. The ICOAP focuses on frequency and intensity of pain, and how pain affects physical function and independence with daily activities. This 11-item measure contains a constant pain subscale (0-20) and an intermittent pain subscale (0-24), with a total score range of 0-44, normalized to 0-100, with higher scores indicative of more severe pain. * The LEFS was used to assess self-report physical function, which was also assessed with several subscales of the KOOS. The LEFS is a 20-item test that assesses subjective difficulty during a variety of movement tasks, and is scored from 0-80, with lower scores indicating poorer physical function. * Physical performances measures of mobility were recommended by the Osteoarthritis Research Society International. They included the six-minute walk test (6MWT), 40-meter walk, 30-second chair stand, timed up and go (TUG), and stair ascent test. The 6MWT measures total walking distance over a six-minute period, and the first 40 meters of this test were used to score the 40-meter walk. The 30-second chair stand measures how many sit-to-stands the participant can perform in 30 seconds, and the TUG measures the time taken to stand up from a chair, walk three meters, and return to sitting in the chair. The chair ascent test measured the time taken to ascend nine stairs as quickly as possible, with or without using a handrail. All outcome measures used are reliable and valid for use in the knee OA population, and improvements in these measures may indicate improved physical function and independence.   Secondary Outcomes:   * Muscle strength of the symptomatic knee was assessed using peak torque of the knee extensors (quadriceps) and knee flexor (hamstrings) muscle groups during maximal volitional effort using a dynamometer. A position of 65 degrees of knee flexion was used, and the torso, pelvis, thigh, and lower leg was stabilized to prevent compensation. Testing was performed after a warm-up and familiarization, and participants performed five maximal volitional isometric contractions for five seconds with five seconds of rest in between each contraction. Visual feedback and verbal reinforcement was provided, and peak torque was expressed relative to body mass. * Depression was measured using the Center for Epidemiological Studies Depression Scale (CESD), which is a 20-item tool with scores than range from 0-60, with higher scores indicating greater depressive symptoms. The test assesses affect (e.g. sleep, worthlessness, mood, guilt, etc.), and has been shown to be reliable in individuals with arthritis. Quality of life was assessed with the quality of life subscale of the KOOS. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.] |
| Statistically significant results (p < 0.05) were found for between-group mean differences/percent differences using an analysis of covariance and a 95% confidence interval for the following outcomes after 12 weeks:  Primary Outcomes:   * KOOS pain, YE vs. NE: The YE group had less pain (22.9 [6.9, 38.8], 52.0% difference, p = 0.003). * Intermittent pain, YE vs. NE: The YE group had less intermittent pain (-19.6, [-34.8, -4.38] -43.6 % differences, p = 0.009). * LEFS score, YE vs NE: The YE group had a greater improvement on the LEFS (17.2 [5.2, 29.2], 45.0% differences, p = 0.003). * LEFS score, TE vs NE: The TE group had a greater improvement on the LEFS (13.9 [2.0, 25.9], 49.8% differences, p = 0.019). * KOOS function in ADL, YE vs NE: The YE group had a greater improvement in ADL function (17.9 [3.8, 32.0], 40.5% difference, p = 0.010). * KOOS function in sport and recreation (SR), TE vs NE: The TE group had a greater improvement in SR (30.8 [3.0, 58.7], 198.0% difference, p = 0.027).   Secondary Outcomes:   * Knee flexor strength (Nm/kg) YE vs TE: The TE group had a greater increase in knee flexor strength (-0.1 [-0.2, -0.1], -28.5% difference, p = 0.028).   As demonstrated above, the YE group demonstrated significantly greater improvements in intermittent pain and KOOS pain than the NE group, whereas the changes in these outcomes between the YE-TE groups and the TE-NE groups were not significant. It should be noted there were no significant changes in constant pain between any of the groups. Additionally, both intervention groups (YE and TE) demonstrated significantly greater self-reported physical function (LEFS) as compared to the control group, but not compared to each other. The TE group demonstrated significantly greater improvements in KOOS SR score compared to NE, and greater increases in knee flexor strength as compared to the YE group. There were no significant changes in physical performance outcome measures between any of the three groups.  The following within-group mean differences between baseline and follow-up with 95% confidence intervals were significantly improved for the YE group:  Primary Outcomes:   * KOOS pain: (21.5 [15.1, 27.9]). Effect size d = 1.71 (large) * Intermittent pain: (-23.7 [-30.9, -16.5]). Effect size d =1.49 (large) * Constant pain: (-24.5 [-40.0, -9.0]). Effect size d =1.10 (large) * LEFS: (10.6 [3.3, 17.9]). Effect size d = 0.99 (large) * KOOS function in ADL: (17.9 [8.7, 27.2]). Effect size d = 1.12 (large) * KOOS function in SR: (21.3 [9.7, 32.9]). Effect size d = 1.14 (large) * 6MWT: (59.3 [22.5, 96.0]). Effect size d = 0.74 (medium) * 30-second chair stand: (3.4 [2.0, 4.8]). Effect size d = 1.31 (large) * Stair ascent: (-1.7 [-2.8, -0.7]). Effect size d = 0.99 (large)   Secondary Outcomes:   * KOOS quality of life: (13.9 [5.7, 22.1]). Effect size d = 0.83 (large)   The following within-group mean differences between baseline and follow-up with 95% confidence intervals were significantly improved for the TE group:  Primary Outcomes:   * Intermittent pain: (-14.3 [-23.4, -5.2]). Effect size d = 0.71 (medium) * 6MWT: (54.0 [28.5, 79.5]). Effect size d = 0.77 (medium) * 40-meter walk: (-2.9 [-5.0, -0.8]). Effect size d = 0.80 (large) * 30-second chair stand: (2.5 [0.9, 4.1]). Effect size d = 0.64 (medium) * Stair ascent: (-0.7 [-1.3, -0.2]). Effect size d = 0.64 (medium)   Secondary Outcomes:   * Knee flexor strength (Nm/kg): (0.1 [0.0, 0.2]). Effect size d = 1.0 (large)   There were no significant within-group mean differences from baseline to follow-up for the NE group. As shown above, both the YE and the TE group experienced many significant improvements over the course of the intervention. The YE group demonstrated significant improvements in many outcomes that the TE did not, such as the KOOS pain, constant pain, LEFS, KOOS function in ADL, SR, and quality of life. The TE group experienced significant improvements in the 40-meter walk and knee flexor strength, which the YE group did not. |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| This yoga intervention was well-tolerated, safe, and efficacious for individuals with knee OA. It was similarly efficacious compared to traditional exercise for reducing pain, improving physical function, and improving quality of life. These findings support that study hypothesis that yoga is a comparable, and in some ways superior exercise program to the traditional gold standard treatment for knee OA. The yoga intervention did not demonstrate significant between-groups improvements compared to the no exercise group for strength and mobility performance measures, nor did the yoga group did not out-perform the traditional exercise group on these outcome measures. Therefore, further studies with larger sample sizes are warranted to investigate the potential superiority of yoga as a safe and efficacious treatment for individuals with knee OA. Additionally, it would be beneficial to include biomechanical analyses of the TE exercises in addition to the YE exercises to assess the KAM during this program. |
| **Critical Appraisal** |
| **Validity**  [Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| Internal validity:  This study used a stringent randomization and blinding procedure. The investigator was uninvolved with interventions, and blinded to group allocation. The instructors of the interventions as well as the participants were blinded to the study hypothesis. These factors help to improve the internal validity of the study by limiting experimenter and systemic bias. The inclusion of two intervention groups as well as a control group also increased the validity of the study, as this study protocol helped demonstrate the cause-and-effect relationship between various treatments and outcomes. However, the low power of this study is a threat to the internal validity. The sample size should have been n = 60 to generate sufficient power; however, the study was only able to recruit 31 participants who met eligibility criteria. Having a low power increases the risk of committing a type II error, which is essentially a false positive.  External validity:  This study uses reasonable inclusion and exclusion criteria. The requirement of a diagnosis of knee OA set forth by the American College of Rheumatology helped to assure that all participants actually had knee OA, which increases the applicability of the findings to the rest of the population. However, it is possible that selection bias may have occurred, as the subjects all volunteered to participate, which may indicate they are more highly motivated than the general population. The fact that the three groups were not statistically different at baseline helps to improve the validity of this study. However, the group sizes were very small (~10), which can certainly impact the validity of the findings. |
| **Interpretation of Results**  [This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| This is an important study that demonstrates that a 12-week biomechanically-based yoga program is a safe and effective way to decrease pain as well as improve function and quality of life for older women with knee OA. The use of physical therapists, kinesiologists, and guidelines set forth by the American College of Rheumatology helped to improve the credibility of this study. The focus on minimizing KAM is very important, as faulty movement patterns throughout exercise and daily activity could actually exacerbate knee OA, which can be extremely detrimental to patients who are encouraged to simply move and exercise more. However, this also presented a confounding variable, as it was difficult to assess whether the superiority of the yoga program was due to the reduced KAM, or whether the improvements were due to other inherent properties of yoga. It would have been useful if the traditional exercise program was also biomechanically-based. Alternatively, future research should be carried out comparing traditional yoga to biomechanically-based yoga, and/or traditional exercise to biomechanically-based exercise for the treatment of knee OA.  Despite the limitations in the study design as well as the small sample size, this was overall an extremely important study that is clinically relevant. The findings of this study demonstrated improvements beyond the MCID for both the YE and the TE group for KOOS and the LEFS: the MCID of the KOOS is 8-10 points, and the MCID of the LEFS is 5 points. The YE group improved by 21.5 and 10.6, respectively, and the TE group improved by 7.6 and 8.3, respectively. Additionally, the intermittent and constant pain subscales of the ICOAP passed the MCID for the YE group only. For almost all of the relevant outcome measures, the YE group experienced extremely large effect sizes. In fact, many of the effect sizes were above 1.0, which means the difference between the baseline and follow-up means for these measures is greater than one standard deviation. Most of the relevant outcome measures for the TE group had medium effect sizes. This shows that both traditional exercise and a yoga program may help people with knee OA improve their physical function and decrease pain over a 12-week period, but yoga may be superior in terms of degree of improvement. |
| **Applicability of Study Results**  [Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| This study is extremely relevant for my clinical scenario, as this patient meets all of the inclusion and exclusion criteria, and is very close to the mean age of the participants. The findings are especially relevant, as this patient has been diagnosed with medial compartment OA, so she should avoid high KAM during exercise and activities. The interventions used in this study are clinically feasible, as long as the clinicians are familiar with the principles of yoga and incorporate education regarding minimizing KAM. The yoga program may be more accessible for many individuals, as yoga does not require access to the expensive strengthening equipment used in the TE program. As both TE and YE may grant significant improvements in symptoms of knee OA, patient preference should be considered when choosing an intervention approach. |

**SYNTHESIS AND CLINICAL IMPLICATIONS**

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

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| These two studies were very valuable, as they demonstrated the safety and effectiveness of yoga as a therapeutic modality for knee OA management. Both studies suggest that participating in yoga for several months may reduce pain, improve self-reported physical function, mobility, and quality of life for older women with knee OA. Yoga is at least as beneficial for knee OA as the traditional gold standard exercise approach, and perhaps superior for pain management, self-reported physical function, and psychological factors such as fear of falling and anxiety. In addition to inherent physical conditioning, yoga can also improve chronic pain coping strategies, self-efficacy, and stress management techniques. The effects of yoga on many of the relevant outcome measures for knee OA were beyond the MCID, indicating that this approach may help improve the quality of life and participation of individuals with knee OA, and may even help these people avoid major surgeries. In addition, the first study also suggests that yoga interventions do not always need to be strictly supervised, as the participants incorporated yoga into their home exercise programs. There were no adverse events associated with the yoga programs for either studies. This is valuable information, as many clinicians and patients may incorrectly assume that yoga is not a safe activity for people with OA to perform without supervision. As traditional exercise also demonstrated statistical and clinical significance for many of the outcomes, patient preference should be considered when choosing the appropriate intervention approach.  Although these studies are clinically important and relevant to the patient scenario of interest, there are inherent weaknesses that impact the quality and validity of the studies. The sample sizes were very small, which ultimately affected the power and internal validity of the studies. Additionally, volunteer bias may limit the generalizability of the findings, as the typical knee OA population may be less motivated to participate in these programs than the subjects of these studies. Also, the yoga interventions in both studies were taught by yoga instructors who may have limited knowledge of pathological conditions as compared to physical therapists. It would be useful to perform studies in which both the intervention groups are treated by physical therapists who incorporate biomechanically-based treatments to better improve the clinical applicability of the results.  Future studies should be performed that investigate biomechanically-based yoga and therapeutic exercise techniques using larger sample sizes, longer treatment times, and long-term adherence. As OA is a chronic disease, it is critical that patients remain adherent to an exercise program over the long-term to manage their symptoms. For these reasons, patient preference is extremely important. Future research should address what factors influence long-term adherence to yoga as well as traditional exercise programs, and how clinicians can best deliver interventions to improve this adherence. For example, it may be found that for many patients, adherence is low for basic strengthening programs, as this type of physical activity is often repetitive, under-stimulating, and performed solo. As yoga can improve self-efficacy and social support, it is likely that long-term adherence may be greater for this type of program. Research should address what patient-specific factors are associated with long-term adherence to yoga (gender, disease duration, age, ethnicity, etc.) to help guide clinicians towards recommendations for the optimal exercise program for each patient. Research should also address how to best increase “buy-in” to yoga programs, as many patients may be dissuaded due to negative associations they may have with yoga due to the media or myths. Developing methods to attract patients with OA towards adhering to yoga practice will help improve the health, functional independence, and quality of life of this population. |

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