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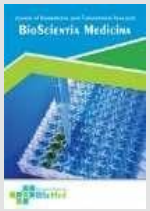

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Impact of Hatha and Iyengar Yoga on Physical Function and Quality of Life in Knee Osteoarthritis: A Systematic Review

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A B S T R A C T

Background: Osteoarthritis (OA) is a chronic degenerative disorder that primarily affects the articular cartilage of synovial joints. This condition leads to pain, joint stiffness, decreased muscle performance, and decreased aerobic capacity, which can negatively impact a patient's quality of life (QOL) and increase their risk of disability. This systematic review aims to investigate the effectiveness of two non-pharmacological treatment regimens, Hatha yoga, and Iyengar yoga, on QOL, physical function, and mental health in patients with knee OA. **Methods:** This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. A comprehensive search was performed across three electronic databases: PubMed, Google Scholar, and ScienceDirect, to identify eligible studies that examined the beneficial effects of Hatha Yoga and Iyengar Yoga on improving physical function, mental health, and QOL in patients with knee OA. **Results:** Out of 61 reports initially identified, 51 were excluded based on the pre-defined inclusion and exclusion criteria. The results of this systematic review suggest that the combination of Hatha Yoga and Iyengar Yoga can enhance physical function, mental health, and QOL in patients with knee OA. **Conclusion:** Both Hatha Yoga and Iyengar Yoga can serve as effective complementary treatments alongside conventional treatment to improve the overall well-being of individuals with knee OA.

1. Introduction

Osteoarthritis (OA) is a prevalent chronic joint disease that affects millions of people worldwide, causing significant pain, disability, and impaired quality of life. It is characterized by the progressive degeneration of articular cartilage, the smooth, white tissue that covers the ends of bones in synovial joints, leading to joint pain, stiffness, inflammation, and functional limitations. Knee osteoarthritis (KOA), in particular, is a common form of OA, with a higher prevalence in women than men, particularly among those with unhealthy lifestyles and obesity. Statistics indicate that approximately one-third of individuals over 50 years of age and middle-aged individuals suffer from KOA, potentially leading to lifelong disability. The progression of KOA is chronic and gradual, primarily characterized by pain, stiffness, and impaired physical function, significantly affecting daily activities such as climbing stairs and squatting. Severe cases may experience intense pain even during walking, further impacting the physical and mental health and quality of life (QOL) of the patient. The burden of knee osteoarthritis extends beyond physical symptoms, impacting psychological well-being, social participation, and economic productivity. Individuals with KOA often experience emotional distress,

including depression and anxiety, due to chronic pain, functional limitations, and reduced quality of life. The disease can also limit social activities and work productivity, leading to social isolation and financial strain.[1,2]

The management of knee osteoarthritis typically involves a combination of pharmacological, non-pharmacological, and surgical interventions. Pharmacological treatments include analgesics such as acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs) to reduce pain and inflammation. However, these medications may provide only temporary relief and can have potential side effects, particularly with long-term use. In some cases, stronger pain medications, such as opioids, may be prescribed, but they carry the risk of dependence and other adverse effects. Non-pharmacological approaches are considered essential in the management of KOA and are often recommended as first-line treatments. These include weight management, exercise, physical therapy, and patient education. Weight loss, even a small amount, can significantly reduce stress on the knee joint and improve symptoms. Exercise, including low-impact activities such as walking, swimming, and cycling, can help strengthen muscles around the knee, improve joint flexibility, and reduce pain. Physical therapy can provide targeted exercises and manual therapy techniques to improve joint function and reduce pain. Patient education plays a crucial role in empowering individuals with KOA to actively participate in their care and make informed decisions about their treatment options. Surgical interventions, such as knee replacement surgery, may be considered for individuals with severe KOA who have not responded to conservative treatments. While surgery can provide significant pain relief and improve joint function, it is a major procedure with potential risks and complications.[3,4]

In recent years, there has been growing interest in complementary and alternative therapies for managing knee osteoarthritis, including yoga. Yoga, an ancient practice originating in India, has gained popularity as a form of exercise and mind-body therapy. It involves a combination of physical postures (asanas), breathing techniques (pranayama), and meditation, promoting physical and mental well-being. Yoga is particularly well-suited for individuals with knee osteoarthritis due to its gentle, low-impact nature. Unlike high-impact activities that can put excessive stress on the knee joint, yoga poses can be modified to accommodate individual needs and limitations. The practice of yoga can help improve muscle strength, flexibility, balance, and joint range of motion, all of which are essential for managing KOA. Several studies have investigated the potential benefits of yoga for individuals with knee osteoarthritis, and the findings have been promising. Yoga has been shown to; Reduce pain and stiffness: Yoga's gentle stretching and strengthening exercises can help reduce pain and stiffness in the knee joint; Improve physical function: Yoga can improve muscle strength, flexibility, and balance, leading to improved physical function and mobility; Enhance mental health: Yoga's meditative and relaxation components can help reduce stress, anxiety, and depression, improving overall mental well-being; Improve the quality of life: By reducing pain, improving physical function, and enhancing mental health, yoga can contribute to an improved quality of life for individuals with KOA.[5,6]

Yoga encompasses various styles, each with its own emphasis and approach. Two styles that have been studied in the context of knee osteoarthritis are Hatha yoga and Iyengar yoga; Hatha yoga is a general term for a traditional style of yoga that emphasizes physical postures and breathing exercises. It is a good choice for beginners and can be adapted to suit individual needs and limitations; Iyengar yoga is a style of yoga that focuses on precise alignment and the use of props, such as blocks, blankets, and straps, to support the body in various poses. It is known for its therapeutic benefits and can be particularly helpful for individuals with musculoskeletal conditions. The potential benefits of yoga for knee osteoarthritis are likely due to a combination of mechanisms, including;

Strengthening muscles around the knee joint: Yoga poses can help strengthen the muscles that support the knee, improving joint stability and reducing pain; Improving flexibility and range of motion: Yoga's stretching exercises can help improve flexibility and range of motion in the knee joint, reducing stiffness and improving mobility; Reducing inflammation: Yoga may help reduce inflammation in the knee joint through its effects on the immune system and stress response; Improving balance and coordination: Yoga can improve balance and coordination, reducing the risk of falls and injuries; Reducing stress and anxiety: Yoga's meditative and relaxation components can help reduce stress and anxiety, which can contribute to pain relief and improved mental health.[7,8] While several studies have investigated the effects of yoga on knee osteoarthritis, the findings have been somewhat inconsistent due to variations in study design, yoga styles, intervention duration, and outcome measures. A systematic review can help synthesize the available evidence and provide a more comprehensive understanding of the potential benefits and limitations of yoga for KOA.[9,10] This systematic review aims to evaluate the effectiveness of Hatha yoga and Iyengar yoga in improving physical function, mental health, and quality of life in individuals with knee osteoarthritis.

2. Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a rigorous and transparent approach to literature search, selection, and synthesis. A comprehensive literature search was performed across three electronic databases; PubMed; Google Scholar; ScienceDirect. These databases were selected for their extensive coverage of biomedical literature, including journals, conference proceedings, and dissertations. The search strategy was designed to identify relevant studies published between 2013 and 2024, encompassing both national and international journals. The search strategy employed a combination of controlled vocabulary (Medical Subject Headings [MeSH] terms) and free-text terms to maximize the retrieval of relevant articles. The following keywords and search terms were used; Hatha Yoga; Iyengar Yoga; Knee Joint Osteoarthritis; Physical Function; Mental Health; Quality of Life. Boolean operators ("AND," "OR") were used to combine search terms and refine the search results.

Studies were included in the review if they met the following criteria; Study design: Cohort studies, observational studies, randomized controlled trials (RCTs), systematic reviews, and meta-analyses; Population: Adults diagnosed with knee osteoarthritis (KOA); Intervention: Hatha Yoga or Iyengar Yoga interventions; Outcomes: Measures of physical function, mental health, and quality of life in patients with KOA; Language: Published in English. Studies were excluded from the review if they met any of the following criteria; Study design: Case-control studies, literature reviews, animal studies; Population: Studies not involving older adults (age < 50 years); Intervention: Studies that did not specifically address the beneficial effects of Hatha Yoga and Iyengar Yoga; Outcomes: Studies that did not include measures of physical function, mental health, or quality of life; Language: Not published in English. The literature search results were imported into reference management software (EndNote) for deduplication and screening. Two independent reviewers screened the titles and abstracts of all retrieved articles to identify potentially eligible studies. The full texts of potentially eligible studies were then retrieved and assessed for inclusion based on the pre-defined inclusion and exclusion criteria. Any disagreements between reviewers were resolved through discussion and consensus.

Data extraction was performed by two independent reviewers using a standardized data extraction form. The following information was extracted from each included study; Study characteristics: Author(s), year of publication, study design, sample size, participant characteristics (age, gender, disease severity); Intervention details: Type of yoga intervention (Hatha

Yoga or Iyengar Yoga), frequency, duration, and intensity of sessions, use of props or modifications; Outcome measures: Specific measures used to assess physical function, mental health, and quality of life; Main findings: Key results related to the effects of yoga on physical function, mental health, and quality of life in patients with KOA The methodological quality of included studies was assessed using the Cochrane Risk of Bias tool for randomized controlled trials and the Newcastle-Ottawa Scale for observational studies. The risk of bias assessment was performed by two independent reviewers, and any disagreements were resolved through discussion and consensus. A qualitative synthesis of the findings from the included studies was conducted. Due to the heterogeneity of study designs, interventions, and outcome measures, a meta-analysis was not feasible. The findings were summarized narratively, focusing on the overall effects of Hatha Yoga and Iyengar Yoga on physical function, mental health, and quality of life in patients with KOA.

3. Results

Figure 1 provides the process of study selection for this systematic review, following the PRISMA flow diagram. Initial searches across PubMed, ScienceDirect, and Google Scholar yielded 16, 2, and 43 articles, respectively, resulting in a total of 61 identified studies. 32 articles were excluded based on their titles not being relevant to the topic (23), not relating to the intervention (7), or being duplicates (2). This left 29 articles for abstract screening. Of the 29 articles, 23 were further excluded due to inappropriate intervention (14), population not being older adults (6), or unsuitable study design (3), leaving 6 articles for full-text review. 1 out of the 6 articles was excluded because the research outcome was not aligned with the review's focus, leaving 5 articles for final inclusion. Ultimately, 5 articles that met all the inclusion criteria and quality standards were included in the systematic review.

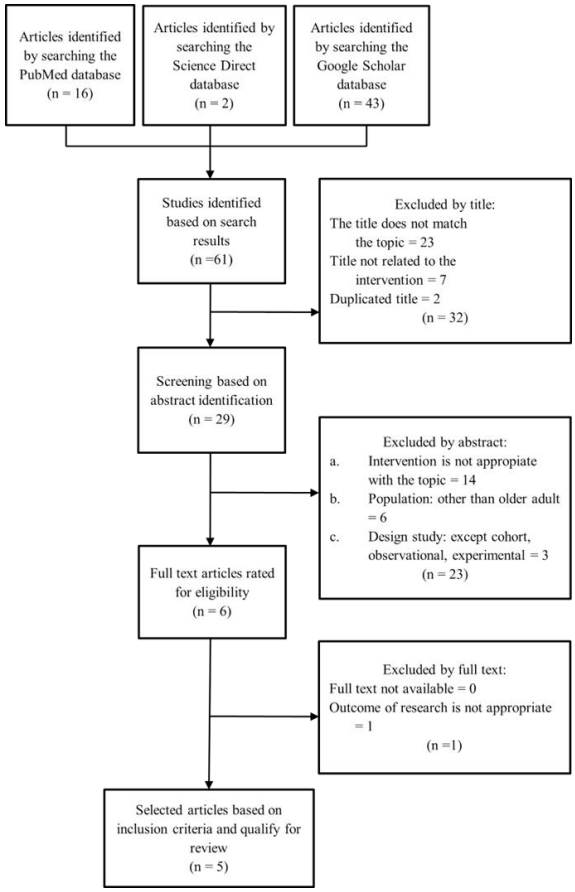

Figure 1. PRISMA flow diagram.

Table 1 provides a summary of the five studies included in the systematic review, detailing the beneficial effects of Hatha Yoga and Iyengar Yoga on individuals with knee osteoarthritis (KOA). The studies included a variety of designs, including randomized controlled trials (RCTs) and comparative analytical studies. The participants were mostly female, with sample sizes ranging from 30 to 250. The age of participants also had a wide range, spanning from middle-aged to older adults. The yoga interventions varied in duration, frequency, and specific poses. Some studies included additional therapies like EMG biofeedback and TENS alongside yoga. The interventions were designed by yoga therapists or expert yoga teachers, ensuring the safety and appropriateness of the practices for people with KOA. All studies reported positive findings, with yoga interventions leading to significant improvements in various outcomes. These included; Improvements in walking capacity, range of knee flexion, pain reduction during walking, and overall physical function scores; Reductions in depression and anxiety scores, improved mood, and decreased fear of falling; Improvements in self-perceived physical and mental health, and overall quality of life scores.

4. Discussion

Yoga asanas are often designed to engage specific muscle groups, providing targeted strengthening exercises for the knee joint. Quadriceps located at the front of the thigh, these muscles are responsible for knee extension (straightening the leg). Weakness in the quadriceps can contribute to knee instability and pain. Hamstrings situated at the back of the thigh, these muscles are responsible for knee flexion (bending the leg). Tight hamstrings can limit knee mobility and contribute to pain. Calf muscles located at the back of the lower leg, play a role in ankle stability and plantarflexion (pointing the foot). Proper calf muscle function is essential for efficient gait and balance, which can indirectly impact knee health. Many yoga poses involve holding static positions that require sustained muscle contractions. These isometric contractions are particularly effective in strengthening muscles without putting excessive stress on the joints. This is crucial for individuals with KOA, as high-impact activities can exacerbate pain and inflammation. Yoga offers a gradual and progressive approach to strengthening. As individuals become more comfortable with basic poses, they can progress to more challenging variations, gradually increasing the intensity and duration of muscle engagement. This progressive overload principle is essential for continued muscle adaptation and strength gains. Yoga not only strengthens individual muscles but also emphasizes functional strength, which is the ability to use muscles in a coordinated manner for everyday activities. This is particularly relevant for individuals with KOA, as improved functional strength can enhance their ability to perform daily tasks with ease and reduce pain. Yoga poses often involve dynamic stretching, which is the movement of a joint through its full range of motion. This type of stretching helps improve flexibility, reduce stiffness, and warm up the muscles and connective tissues around the knee. Many yoga poses also incorporate static stretching, which involves holding a stretch for an extended period. Static stretching can help lengthen muscles and improve flexibility, reducing tightness that can restrict movement and contribute to pain. Some yoga poses utilize PNF techniques, which involve alternating between contracting and relaxing muscles to achieve a deeper stretch. PNF can be particularly effective in improving flexibility and range of motion. Yoga practices can also help release tension in the fascia, the connective tissue that surrounds muscles and organs. Fascial restrictions can limit movement and contribute to pain. Yoga poses that involve gentle twists, stretches, and self-massage can help release fascial tension and improve overall mobility. Movement through yoga poses promotes the circulation of synovial fluid, the lubricating fluid within the knee joint. This improved lubrication can reduce friction between the joint surfaces, easing movement and reducing pain.

Table 1. Summary of studies about the beneficial effects of Hatha Yoga and Iyengar Yoga on improving physical function, mental health, and quality of life in patients with knee joint osteoarthritis.[5-9]

No	Author	Year	Design study	Sample (n)	Treatment	Findings
1	Moonaz, et al.	2015	Randomized controlled pragmatic trial	Participants were mostly female (96%), white (55%), and college-educated (51%) with a mean (SD) age of 52 years (12 yrs). The average disease duration was 9 years and 49% had RA.	Treatment arms. Yoga consisted of 60-min classes held twice weekly for 8 weeks at 2 hospital-affiliated fitness centers in Baltimore, Maryland, USA The program was designed by a registered yoga therapist (SM) with input from the Johns Hopkins Arthritis Center faculty, Two yoga therapists with 10+ years of experience taught the classes. Yoga therapists have additional training to address the needs of people with diverse conditions/abilities.	Participants were mostly female (96%), white (55%), and college-educated (51%). with a mean (SD) age of 52 years (12 yrs). The average disease duration was 9 years and 49% had RA. At 8 weeks, yoga was associated with significantly higher PCS (6.5.95% CI 2.0-10.7). walking capacity (125 m. 95% CI 15-235). positive affect (5.2.95% CI 1.4-8.9). and lower Center for Epidemiologic Studies Depression Scale (-3.0, 95% CI -4.8 - -1.3). Significant improvements ($P < 0.05$) were evident in SF-36 role physical, pain. general health. vitality, and mental health scales. Balance. grip strength and flexibility were similar between groups. Twenty-two out of 28 in the waitlist group completed yoga. Among all yoga participants, significant ($p < 0.05$) improvements were observed in mean PCS. flexibility. 6-min walk, and all psychological and most HR QOL domains at 8 weeks with most still evident 9 months later. Of 7 adverse events, none were associated with yoga.
2	Cheung, et al.	2014	A pilot randomized controlled trial	Eligible participants (N = 36; mean age 72 years) were randomly assigned to an 8-week yoga program involving group and home-based sessions or wait-list control.	The yoga program was composed of one 60-minute Hatha yoga class per week for eight weeks. Sessions included asanas (poses) in the seated, supine, and standing positions; pranas (breathing); and meditation. A progressive series of poses was used with static stretching, balance, and strength exercises. Classes were designed by a panel of five certified/registered yoga teachers who had experience teaching older adults. The program was reviewed by two yoga researchers and a yoga master.	A total of 82 potential participants were screened. Fifty-six of them met the inclusion criteria and were eligible for a second screening. Recruitment took nine months. Thirty-six community-dwelling older women with knee OA who met all the study criteria and were able to commit to the duration of the yoga intervention program were enrolled. The remaining potential participants were excluded for a variety of reasons, the major ones being hip/knee replacement or already in an exercise program. Data were collected at four-time points (baseline, 4 weeks during treatment, 8 weeks, and 20 weeks) and the trial was ended after the follow-up data were collected from both treatment and waitlist control groups.

3	Ebnezar, et al.	2012	A Randomized Controlled Study	Two hundred and fifty (250) participants who had OA knees and who were between 35 and 80 years (yoga 59.56 – 9.54) and (control 59.42 – 10.66) from the outpatient department of Ebnezar Orthopedic Center, Bengaluru, were randomly assigned to receive hatha yoga therapy or therapeutic exercises after transcutaneous electrical stimulation and ultrasound treatment (20 minutes per day). Both of the groups practiced supervised interventions (40 minutes per day) for 3 months. One hundred and eighteen (118) (yoga) and 117 (control) subjects were available for the final analysis.	The daily routine practiced at the center in the yoga group included 40 minutes of integrated yoga therapy practice after 20 minutes of physiotherapy with transcutaneous electrical stimulation and ultrasound for 2 weeks. The integrated yoga therapy practice included shithilikarana vyayamas (loosening practices), sakti vikasaka (strengthening practices), followed by yogasanas and relaxation techniques with devotional songs. Later patients were advised to continue the integratedyoga therapy practice for 40 minutes at home for the next 10 weeks.	There were significant differences within (Wilcoxon's, $p<0.001$) and between the groups (Mann–Whitney U, $p<0.001$) on all the variables, with better improvements in the yoga than the control groups. Walking pain in the yoga (37.3%, 64.9%) and control (24.9%, 42%), knee disability in the yoga (59.7%, 83%) and control (32.7%, 53.6%), range of knee flexion in yoga (12.7%, 26.5% right, 13.5%, 28% left) and control (6.9%, 13.3% right, 5.6%, 11.5% left), joint tenderness in yoga (52.3%, 86.1%) and control (28%, 57.1%), swelling in yoga (55.4%, 85.9%) and control (32.1%, 60%), crepitus in yoga (44.0%, 79.9%) and control (27.0%, 47.8%) and walking time in yoga (26.6%, 52.8%) and control (9.3%, 21.6%), all improved more in the yoga than the control groups on the 15th and 90th day, respectively.
4	Nambi, et al.	2013	Comparatif Analytical	Thirty subjects who have fulfilled inclusion and exclusion criteria were selected and divided into two groups (Group A and B).	Both the groups were treated with EMG biofeedback, knee muscle strengthening exercises, and TENS. Group A received additionally Iyengar Yoga for 8 weeks. Both groups were evaluated by Visual Analog Scale and Modified WOMAC–Western Ontario McMaster Universities Scale.	Patients in both groups experienced significant reduction in pain and improvement in functional ability. In VAS scale Group A showed reduction of 56.83% ($P = 0.001$) when compared with Group B 38.15% ($P \leq 0.001$). In modified WOMAC Scale, Group A showed reduction of 59.21% ($P = 0.001$) when compared with Group B 34.08% ($P = 0.001$).
5	Cheung, et al.	2017	Parallel Randomized Controlled Trial	Eight-three adults with symptomatic knee OA completed the study (84% female; mean age 71.6 ± 8.0 years; mean BMI 29.0 ± 7.0 kg/m2).	The Hatha Yoga (HY) program was designed by a group of expert yoga teachers and was composed of one 45-min class per week for eight weeks and additional 30 min/day, four times/week of yoga practice at home during the intervention period. Sessions included poses in the seated, supine, prone, and standing positions; breathing exercises, and relaxation/mindfulness training. Key yoga poses included "easy" seated pose, reclining bound angle, half locust variation, head to knee pose, bridge, standing forward fold, chair pose, mountain pose, warrior I and II, tree pose variation, reclining hamstring stretch with hip opener with strap, reclining twist, and relaxation pose.	Compared to the ASE group at 8 weeks, participants in the HY group had a significant improvement from baseline in perception of OA symptoms (−9.6 [95% CI −15.3, −4]; $p = .001$), anxiety (−1.4 [95% CI −2.7, −0]; $p = .04$), and fear of falling (−4.6 [−7.5, −1.7]; $p = .002$). There were no differences in class/ home practice adherence between HY and ASE. Three non-serious adverse events were reported from the ASE group. Both HY and ASE improved symptoms and function but HY may have superior benefits for older adults with knee OA.

The combination of improved muscle strength and flexibility is crucial for maintaining optimal knee joint health. Stronger muscles provide better support for the joint, while increased flexibility ensures a full range of motion and reduces stiffness. This synergy helps improve overall joint function, reduce pain, and enhance the quality of life for individuals with KOA.[11,12]

The hypothalamic-pituitary-adrenal (HPA) axis is a complex neuroendocrine system that plays a central role in the body's response to stress. When we experience stress, the HPA axis is activated, leading to the release of cortisol, a hormone that helps the body cope with the perceived threat. However, chronic stress can lead to prolonged elevation of cortisol levels, which can have detrimental effects on the body, including increased inflammation. Yoga practices, particularly those that incorporate meditation, deep breathing, and relaxation techniques, have been shown to modulate the HPA axis and reduce cortisol levels. This downregulation of the stress response can help dampen the inflammatory processes associated with KOA. Yoga may also influence the release of neurotransmitters, such as endorphins and GABA, which have pain-relieving and mood-boosting effects. These neurochemical changes can further contribute to reducing inflammation and improving overall well-being. Cytokines are signaling molecules that play a crucial role in regulating the immune response. In KOA, there is an imbalance of cytokines, with an increase in pro-inflammatory cytokines (e.g., IL-1β, TNF-α) and a decrease in anti-inflammatory cytokines (e.g., IL-10). This imbalance contributes to the chronic, low-grade inflammation that drives cartilage degradation and pain. Studies suggest that yoga can help restore balance to the immune system by reducing pro-inflammatory cytokines and increasing anti-inflammatory cytokines. This immunomodulatory effect can help mitigate the inflammatory processes associated with KOA and promote healing. Yoga may also help reduce oxidative stress, which is an imbalance between the production of free radicals and the body's ability to neutralize them. Oxidative stress can contribute to inflammation and cartilage damage in KOA. Yoga's antioxidant effects may help protect against oxidative damage and reduce inflammation. The neuroendocrine and immune systems are intricately interconnected, with bidirectional communication pathways. Stress and inflammation can influence each other, creating a vicious cycle that can exacerbate KOA symptoms. Yoga's ability to modulate both the neuroendocrine and immune systems may help break this cycle and promote healing. Proprioception refers to the body's ability to sense its position, movement, and orientation in space. It is essential for maintaining balance, coordination, and joint stability. In individuals with KOA, proprioception may be impaired due to damage to the joint structures and surrounding tissues. This impairment can lead to instability, altered gait patterns, and an increased risk of falls. Yoga poses often challenge balance and require focused attention on body positioning. This can help enhance proprioception by stimulating the sensory receptors in the muscles, tendons, and joints. As individuals practice yoga, they become more attuned to their body's subtle movements and adjustments, improving their proprioceptive awareness. Improved proprioception leads to better balance and coordination, reducing the risk of falls and subsequent injuries that can worsen KOA. It also helps individuals with KOA move with more confidence and stability, improving their ability to perform daily activities and participate in social activities. Yoga practices emphasize coordinating movement with breath, promoting neuromuscular control and stability around the knee joint. This mindful approach to movement helps individuals develop greater awareness of their muscle activation patterns and joint alignment. Many yoga poses require precise movements and controlled muscle activation. This helps refine neuromuscular control, improving the efficiency and coordination of muscle contractions around the knee joint. Enhanced neuromuscular control helps maintain proper joint alignment and movement patterns, minimizing abnormal stress on

the knee joint and reducing pain. It also improves stability and reduces the risk of injury during movement. Proprioception and neuromuscular control work together to optimize movement and maintain joint stability. Proprioception provides sensory feedback about the body's position and movement, while neuromuscular control allows for precise and coordinated muscle activation to maintain balance and stability. Yoga practices that challenge balance and require coordinated movement can enhance both proprioception and neuromuscular control, leading to significant improvements in joint stability and function.[13,14]

Yoga is not merely a physical exercise, it is a holistic practice that recognizes the intricate connection between the mind and body. This mind-body connection is central to yoga's ability to reduce stress and anxiety, which can significantly impact pain perception and overall well-being in individuals with KOA. Chronic stress can exacerbate pain perception and contribute to muscle tension, further aggravating KOA symptoms. When we experience stress, the body releases stress hormones, such as cortisol, which can increase inflammation and sensitivity to pain. Stress can also lead to muscle tension, which can restrict movement and worsen joint pain. Yoga practices, particularly those that incorporate deep breathing, mindfulness, and meditation, elicit the relaxation response, a state of deep calmness and physiological quieting. This relaxation response counteracts the stress response, reducing the production of stress hormones and promoting muscle relaxation. By reducing stress and promoting relaxation, yoga can help break the vicious cycle of stress, muscle tension, and pain that often accompanies KOA. This can lead to a significant improvement in pain management and overall quality of life. Pain is not simply a sensation, it is a complex experience that is influenced by various factors, including our thoughts, emotions, and past experiences. The brain plays a crucial role in processing and interpreting pain signals. The relaxation response elicited by yoga practices can influence pain perception pathways in the brain, reducing the intensity and unpleasantness of pain. This effect may be mediated by changes in neurotransmitter activity, such as increased levels of endorphins, which have pain-relieving effects. Yoga practices often incorporate mindfulness, which involves paying attention to the present moment without judgment. Mindfulness can help individuals with KOA develop a greater awareness of their pain without reacting to it with fear or anxiety. This acceptance of pain can reduce its emotional impact and improve coping mechanisms. Yoga has been shown to improve mood and emotional regulation, which can be particularly beneficial for individuals with KOA who may experience depression or anxiety due to chronic pain and functional limitations. Yoga can help individuals develop healthy coping mechanisms for stress and anxiety, improving their ability to manage pain and navigate the challenges of living with KOA. Yoga can empower individuals with KOA by increasing their self-efficacy, which is the belief in one's ability to manage their condition and achieve their goals. This increased self-efficacy can lead to greater adherence to treatment plans and improved outcomes. In today's fast-paced world, it's easy to become disconnected from our bodies, moving through our daily activities without paying attention to the subtle signals our bodies send us. This lack of body awareness can contribute to poor posture, inefficient movement patterns, and increased risk of injury. For individuals with KOA, this disconnect can exacerbate pain and limit their ability to engage in activities they enjoy. Yoga, with its emphasis on mindful movement, offers a powerful antidote to this disconnect. By bringing attention to the sensations and alignment of the body during each pose, yoga cultivates a heightened sense of body awareness. Increased body awareness helps individuals become more attuned to the sensations in their bodies, allowing them to identify specific movements or activities that trigger their pain. This awareness empowers them to modify their activities or avoid movements that exacerbate their symptoms. By

paying close attention to their body's alignment and movement patterns during yoga practice, individuals with KOA can identify and correct imbalances or inefficient movements that may be contributing to their pain. This can lead to more efficient and pain-free movement in daily life. Kinesthetic awareness refers to the body's ability to sense its movement and position in space. Yoga enhances kinesthetic awareness by encouraging individuals to pay close attention to the subtle sensations of their muscles stretching, joints moving, and balance shifting. This improved kinesthetic awareness can translate into better coordination, stability, and reduced risk of falls. Mindful movement in yoga fosters a deeper connection between the mind and body. This connection allows individuals to become more attuned to their body's signals, not just physical sensations but also emotional and mental states. This holistic awareness can lead to a greater sense of self-care and well-being. Increased body awareness empowers individuals with KOA to take a more active role in their self-care. By understanding how their bodies move and respond to different activities, they can make informed choices about their daily activities and develop strategies to protect their joints and manage their condition. With increased body awareness, individuals with KOA can identify activities that exacerbate their pain and modify them accordingly. This may involve adjusting their posture, using assistive devices, or pacing themselves to avoid overexertion. Increased body awareness can also translate into greater ergonomic awareness, allowing individuals with KOA to make adjustments to their workspaces and home environments to reduce strain on their joints. Body awareness can extend beyond physical activity to encompass lifestyle choices that impact KOA, such as maintaining a healthy weight, getting adequate sleep, and managing stress. By becoming more attuned to their body's signals, individuals with KOA can identify early signs of pain or inflammation and take proactive steps to manage their condition. This may involve modifying their activities, applying heat or cold therapy, or practicing relaxation techniques.[15,16]

The studies included in this systematic review generally concur that yoga interventions, encompassing both Hatha and Iyengar styles, yield improvements in physical function for individuals with knee osteoarthritis (KOA). This aligns with a broader body of research that underscores the benefits of exercise in managing KOA and enhancing physical capabilities. Yoga appears particularly advantageous due to its holistic nature, integrating physical postures with breathing exercises and meditation, which may confer additional benefits for pain reduction and relaxation, further contributing to improved physical function. The strength of muscles surrounding the knee joint, primarily the quadriceps, hamstrings, and calf muscles, is crucial for joint stability and support. Yoga postures that engage these muscle groups in weight-bearing and isometric contractions can enhance strength, improving joint stability and reducing pain during movement. Restricted range of motion and joint stiffness are common complaints among individuals with KOA. Yoga's diverse array of stretches, including dynamic and static stretches, can improve flexibility in the muscles and connective tissues surrounding the knee, promoting ease of movement and reducing stiffness. Impaired balance is a significant concern for individuals with KOA, increasing their risk of falls and subsequent injuries. Yoga poses that challenge balance, such as standing poses and balancing sequences, can enhance proprioception and neuromuscular control, leading to improved balance and reduced fall risk. Abnormal gait patterns are often observed in individuals with KOA, contributing to pain and functional limitations. Yoga practice can help improve gait by strengthening and stretching key muscle groups, enhancing balance, and promoting body awareness. This can lead to a more efficient and pain-free gait, improving mobility and reducing the risk of falls. Functional capacity refers to an individual's ability to perform daily activities, such as walking, climbing stairs, and rising from a chair. Yoga practice can enhance functional capacity by improving muscle strength, flexibility, balance, and gait. This can

lead to greater independence and participation in daily activities, improving overall quality of life. Hatha yoga, with its emphasis on physical postures and breathing exercises, may be particularly beneficial for improving muscle strength and flexibility. The diverse range of poses in Hatha yoga can be adapted to accommodate varying levels of ability and target specific muscle groups relevant to KOA. Iyengar yoga, characterized by its focus on precise alignment and the use of props, may be particularly effective in improving balance and coordination. The use of props, such as blocks, blankets, and straps, provides support and allows for modifications to suit individual needs and limitations. Other styles of yoga, such as Vinyasa and restorative yoga, may also offer benefits for physical function in KOA. Vinyasa yoga, with its flowing sequences of poses, can improve cardiovascular fitness and coordination. Restorative yoga, with its gentle poses and emphasis on relaxation, can help reduce pain and promote healing. Yoga should be considered as part of a comprehensive management plan for KOA, complementing other interventions such as weight management, physical therapy, and medication. The benefits of yoga for physical function can be further enhanced when combined with other evidence-based treatments. The studies encompassed in this systematic review highlight a compelling trend: yoga interventions, encompassing both Hatha and Iyengar styles, appear to confer significant benefits to the mental health of individuals grappling with knee osteoarthritis (KOA). This observation aligns with a growing body of research that underscores the positive impact of yoga on mental well-being across diverse populations. The multifaceted nature of yoga, integrating physical postures, breathing exercises, and meditation, seems particularly well-suited to address the emotional and psychological challenges that frequently accompany chronic pain conditions like KOA. KOA's impact extends beyond physical discomfort, often casting a shadow on emotional and psychological well-being. Persistent pain, reduced mobility, and social isolation can increase the risk of depression in individuals with KOA. Depression can further exacerbate pain perception and reduce motivation to engage in self-care activities, creating a detrimental cycle. The uncertainty and limitations imposed by KOA can trigger anxiety, particularly regarding the future progression of the condition and its impact on daily life. Anxiety can heighten pain perception, disrupt sleep, and contribute to muscle tension, further aggravating KOA symptoms. The challenges of managing a chronic condition like KOA can lead to chronic stress, which can have detrimental effects on both physical and mental health. Stress can exacerbate inflammation, impair immune function, and disrupt sleep, further complicating the management of KOA. Yoga's emphasis on deep breathing, mindfulness, and meditation elicits the relaxation response, counteracting the physiological effects of stress. This can help reduce anxiety, improve mood, and promote emotional regulation. Yoga encourages mindfulness, a state of non-judgmental awareness of the present moment. This can help individuals with KOA develop a greater understanding of their thoughts, emotions, and physical sensations, fostering self-awareness and emotional regulation. Yoga provides tools and techniques for managing stress, anxiety, and pain, empowering individuals with KOA to develop healthy coping mechanisms. This can lead to greater resilience in the face of challenges and improved quality of life. Group yoga classes can provide a sense of community and social support, which can be particularly beneficial for individuals with KOA who may experience social isolation due to their condition. Yoga's emphasis on self-acceptance and non-judgment can promote a positive self-image, which can be particularly important for individuals with KOA who may experience body image concerns due to physical limitations. Several studies found that yoga interventions led to significant reductions in depressive symptoms, improving mood and overall emotional well-being. Yoga practice was associated with decreased anxiety levels, reducing worry, fear, and tension related to KOA. Yoga's relaxation effects can promote better sleep quality, which is often disrupted in individuals with KOA due to pain and

discomfort. Yoga can foster resilience, the ability to bounce back from adversity, by providing individuals with KOA with tools and techniques to manage stress, anxiety, and pain.[17,18]

5. Conclusion

This systematic review synthesized evidence from five studies exploring the effects of Hatha and Iyengar yoga on individuals with knee osteoarthritis. The findings suggest that both styles of yoga may be beneficial as complementary therapies for this condition. Specifically, yoga interventions demonstrated the potential to improve physical function, enhance mental health by reducing stress and anxiety, and potentially improve the overall quality of life. However, it is crucial to acknowledge the limitations of this review, including the small number of studies and the heterogeneity in study designs and outcome measures. Further rigorous research with standardized protocols and larger sample sizes is needed to confirm these findings and provide more definitive recommendations for the use of yoga in managing knee osteoarthritis.

6. References

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