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**Original Research Article**

# Influence of yoga on pain, lower extremity kinetics, kinematics and function in patients with knee osteoarthritis

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## ABSTRACT

**Background:** Knee osteoarthritis (OA), is one of the leading cause of disability that causes significant reduction in function and strength with an increase in pain. The present study evaluates effects of Yoga with Physiotherapy exercises on pain, kinetics, kinematics and function in patients with knee osteoarthritis.
**Methods:** A randomized controlled trial was conducted for evaluating the effect of Yoga on pain, lower limb kinetics, kinematics and function in patients with knee osteoarthritis over a period of 6 weeks. A total of 50 participants volunteered for the study. The participants were randomly allocated into Control group (n=25) and Intervention group (n=25). The participants of control group performed conventional exercises. The participants of intervention group performed conventional exercises along with Yoga.
**Results:** Findings from present study reported significant improvement in muscle flexibility of Rectus Femoris ($p<0.05$) and Tensor Fascia Lata ($p<0.05$) in the interventional group as compared to the control group. There was a significant improvement in knee flexion range of motion($p<0.05$) in the interventional group compared to the control group. Lower extremity muscle strength evaluation demonstrated a significant improvement($p<0.05$) in muscle strength of hip and knee musculature in the interventional group as compared to the control group. There was a significant reduction in pain scores($p<0.05$) for stair climbing in the interventional group as compared to the control group. There was no significant improvement in function pre and post intervention.
**Conclusions:** Findings from present study report yoga practice improves knee flexion range of muscle, muscle strength and flexibility in patients with knee osteoarthritis.

**Keywords:** Crossed leg sitting, Function, Knee osteoarthritis, Pain, Physiotherapy exercise, Strength, Yoga

## INTRODUCTION

Knee osteoarthritis (OA), also known as degenerative joint disease, is typically the result of wear and tear and progressive loss of articular cartilage. It is a chronic condition with a multifaceted aetiology that results in subchondral sclerosis, enlargement of the bone at the borders, and a variety of biochemical and morphological changes to the synovial membrane and joint capsule. Typical clinical symptoms are pain, particularly after prolonged activity and weight-bearing; whereas stiffness is experienced after inactivity.[1] There are several risk factors for OA such as obesity, smoking, intra articular fractures, chondrocalcinosis, crystals in joint fluid/cartilage, female gender, prolonged immobilization, joint hypermobility, instability, peripheral neuropathy, prolonged occupational, or sports stress. The prevalence of knee osteoarthritis increases with age.[2]

Contrary to popular perception, a radiograph is not necessary for the clinical diagnosis of knee osteoarthritis (OA). The patient's age, symptoms, and clinical findings can be used to make a clinical diagnosis of knee OA, with or without the use of radiographs. The ACR clinical classification criteria can be used for diagnosis of osteoarthritis of knee. The presence of knee pain along with at least three of the following six items can classify as knee osteoarthritis in patients: age above 50 years, morning stiffness lasting less than 30-minute, crepitus on knee motion, bony tenderness, bony enlargement, no palpable warmth.[3]

The total prevalence of osteoarthritis in India is reported to range from 27.1% to 66.1%. The frequency rises with age, is considerably more common in women (51%, range: 31.6-77) than men (33.09%, range: 28.1-61.5). Osteoarthritis is known to be more prevalent in urban areas compared to rural areas and affects individuals with higher Body Mass index (BMI). Knee osteoarthritis was reported to be most common in individuals with sedentary lifestyles and low levels of physical activity.[4]

Osteoarthritis is known to constitute an immense social, health (including physical and psychological) burden. Approximately 3.3% to 3.6% of the global population is affected with osteoarthritis resulting into moderate to severe disability. Joint pain, stiffness, movement difficulties and incidences of falls are outcomes of physical health impairments.

Anxiety and depression constitute psychological health results for osteoarthritis. Withdrawal from occupational tasks and social participation are categorised as social consequences. The economic burden comprises of direct and indirect costs. Direct costs include the medical and surgical expenses incurred for management of osteoarthritis and indirect costs involve absenteeism from work leading to reduction in work productivity.[5]

Sedentary lifestyle has detrimental impacts on one's health. It has been shown to exacerbate all known causes of mortality, in addition to increasing the risk of osteoporosis, cardiovascular and metabolic illnesses, anxiety, depression, and various types of cancer.[6] There is evidence of a connection between a sedentary lifestyle, obesity, chronic inflammatory disease, and osteoarthritis symptoms, as well as a dose-response relationship between the degree of sedentarism and the severity of osteoarthritis symptoms.[7]

Maintaining cartilage and muscle mass requires regular mechanical stress, such as that attained during moderate to strenuous adapted physical activity.[8,9] However, not all types of mechanical stress led to the same biological responses.[10] Mechanosensitive cells called articular chondrocytes produce extracellular matrix in response to mild, cyclic mechanical stress. However, research using in vivo and in vitro models demonstrates that excessive mechanical stress can activate the apoptotic pathway and encourage cell death.[11] A sedentary lifestyle-induced obesity can place undue strain on the joints and cause osteoarthritis at a young age.

Physiotherapy is a crucial component of managing OA and is helpful in teaching people joint protection techniques, range of motion, stretching, and strengthening exercises, in addition to cardiovascular exercises (such as walking, cycling, and hydrotherapy), recommending assistive devices, and advising on the use of modalities (such as heat or cold therapies, TENS).

Yoga is an ancient practice focussing to offer a comprehensive sense of well-being of the body and mind. The blended approach of yoga incorporated various elements of yogic poses (asana), breathing practices (pranayama) and meditation (dhyana) and relaxation practices, along with moderation in lifestyle. Yoga is secure to practice, requires a low-to-moderate level of supervision and is economic to maintain because of minimal equipment requirement.[5]

Nowadays, Yoga is gaining more and more popularity all over the world as a way to acquire and maintain health and well-being. In clinical settings, yoga has been utilised as a therapeutic intervention to reduce pain, stiffness, edema, and increase mobility in older persons. Yoga poses can be easily modified in accordance with individual capabilities and limits, making it suitable for use by people with OA. Additionally, it has been demonstrated that the breathing techniques and mental techniques used in yoga can change the stress response by Benvenutti et al; Gothe et al; Schmalzl et al, and as a result, they can be used to alleviate pain by Harth et al; Somers et al; Sorel et al.

Osteoarthritis causes significant changes in the kinetics and kinematics at the knee joint. There were very few studies reporting the effect of yogasanas on patients with osteoarthritis of knee. Yoga is known to have a positive effect on mental and spiritual domains of health in addition to improving muscle strength, flexibility and balance. The practice of delivering regular yoga exercises is speculated to improve muscle length, balance and coordination in older adults diagnosed with knee osteoarthritis. However, the reported effects of yoga on knee osteoarthritis are inconsistent.[12]

## METHODS

The study commenced after receiving ethical approval from the Institute's Ethics Committee. Participants were explained in detail about the purpose of the study, procedure, clinical evaluation, equipment's used and benefits of the study in a language best understood by them. An informed consent was sought from all participants. The sample size was calculated using the GPower software. A purposive random sample of fifty participants with knee osteoarthritis in the age group of 45 years and above as per the ACR diagnostic criteria were recruited. Participants fulfilling the inclusion criteria were recruited for the study. The participants were assessed pre intervention (0 weeks) and post intervention (at the end of 6 weeks) for muscle flexibility, range of motion, muscle strength, pain on activities and function. The study was carried out from November 2023 to December 2023.

Muscle flexibility of rectus femoris, tensor fascia latae, hip flexors and hamstrings were assessed using prone knee bending test, Ober's test, Thomas test and 90-90 test respectively. Range of motion was assessed using a universal goniometer. Muscle strength was assessed using MRC grading for muscle strength assessment. Numerical pain rating scale was used to assess pain on squatting, crossed leg sitting, stair climbing and walking. Lower limb function was assessed using Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

The control group was administered conventional exercises for knee osteoarthritis. The interventional group also underwent the conventional exercises along with Yoga asanas. The yogasanas administered were Virabhadrasana (Warrior pose), Setu bandhasana (bridging pose), Ardha Matsyendrāsana (Half lord of the fishes pose), Supta baddha konasana (Reclined butterfly pose) and Gomukhasana (Cow face pose).

Instructions given for Yoga poses were as follows:

***Virabhadrasana (Warrior pose)***

Stand upright with your legs shoulder width apart. Rotate one foot by 90 degrees outwards and the other foot about 15 degrees. Put your hands on your hips and rotate your shoulders, chest, and pelvis forward. Upper body facing the front of the mat. While inhaling, draws the arms from the sides over your head. Maintain your palms in a namaste pose over your head. Flex the back knee and exhale deeply maintaining it directly in line with the other ankle. The thigh should be parallel to the floor. Make sure the flexed knee does not pass the ankle and the big toe is visible. Arch your back and fall your head back, gaze upwards towards your adjoined hands. Ground down the front foot ensuring the outer edge of the foot is pressed firmly on the mat. Hold the pose for 10-20 seconds. Inhale and extend your back leg; then exhale and release your arms, stepping your feet together. Change sides and repeat the same steps.

***Setu bandhasana (bridging pose)***

Lying on your back, bend both knees and place the feet flat on the floor hip width apart. Slide the arms alongside the body with the palms facing down. The fingertips should be lightly touching the heels. Press the feet into the floor, inhale and lift the hips up, rolling the spine off the floor. Lightly squeeze the knees together to keep the knees hip width apart. Press down into the arms and shoulders to lift the chest up. Engage the legs, buttocks and mula bandha to lift the hips higher. Breathe and hold for 4-8 breaths.

***Ardha Matsyendrāsana (half lord of the fishes pose)***

Exhaling bend the right the leg and place the foot outside the left knee. Exhaling bend the left knee and place the sole to the right hip from outside. Inhaling raise the left arm up. Exhaling then catch the right big toe from outside of the right leg. Maintain the final position with normal breathing. Gaze at the right side while in the final position. Repeat the practice on another side after 5 breathing.

***Supta baddha konasana (reclined butterfly pose)***

Start with a sitting dandasana, i.e., sit with your spine erect and legs stretched out, feet touching each other and toes pointing upwards. Now bend your knees and bring your feet towards the pelvis. The soles of your feet should touch each other, making a diamond shape with legs. Grab your feet with your hands. You may place the hands underneath the feet for support and make an effort to bring the heels as close to the genitals as possible. Gently breathe in and make a gentle effort to make the chest and the spine erect. Once you feel comfortable, you may gently lie down and rest your back on the floor. Your arms can rest on your inner thighs. Relax your muscles and take 5-10 deep breaths in this position. To come out, you can either stretch your legs and relax for a few minutes. Then roll onto your right side and with the help of your hands gently sit up.

***Gomukhasana (cow face pose)***

Start in long sitting position. Bend the right knee. Bring your left foot to the outside of your right hip, weaving it underneath your right knee. Bring your right foot to the outside of your left hip, so that your right knee is stacked on top of your left knee. Ground through your sitting bones. As you inhale, lengthen your spine and stretch your arms out to the sides, palms facing forward. Internally rotate your right shoulder so that your palm faces to the wall behind you and your thumb points down. Sweep the arm behind your back, walking your hand up between your shoulder blades, palm facing outwards. Stretch the left arm up, fingertips pointing towards the ceiling, the palm of your hand still facing forward. Bend the elbow and reach down for the right fingertips, hooking the fingers together if they reach. Firm your shoulder blades against your back ribs and open your chest. Maintain this position for a few breaths. To come out of the pose, release the arms, uncross the legs and repeat on the other side. Remember to switch legs as well as the arms. Whichever knee is stacked on top, the opposite side elbow is pointing upwards

***Statistical analysis***

Data was analysed using SPSS software (Version 24; USA, 2019) and Shapiro- Wilk test was used to assess normality. For the inter group analysis, the data followed normal distribution hence, independent t-test was applied. For the intra group analysis, the data followed normal distribution hence, paired t-test was applied. A statistical significance level of 0.05 was set for inferential testing.

## RESULTS

A total of 50 (25 - control group and 25 - intervention group) participants were enrolled for the study. The demographic details of participants in both the groups is presented in Table 1. The mean age of group A was 56.4 and group B was 56.8 respectively. Male to female ratio is 1:2.8 for control group and 1:2.5 for intervention group. The demographic details of group A and B are given in Table 1 and 2.

**Table 1: Demographic details of participants in control and interventional group.**

| Variable | Control group (Group A) (n=25) | | Interventional group (Group B) (n=25) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Age (yrs.) | 56.40 | 8.35 | 56.8 | 10.91 |
| Males | 8 | | 10 | |
| Females | 17 | | 15 | |

The scores for evaluation of flexibility with effect size is presented in Table 2 for both control and interventional groups. There was a significant improvement in muscle flexibility of the rectus femoris and tensor fascia latae as measured on prone knee bending test and Obers test in the interventional group as compared to the control group.

Scores and effect size for evaluation of range of motion for both control and interventional groups is presented in Table 3. There was a significant improvement in knee flexion range of motion in the interventional group compared to the control group.

Evaluation of lower extremity muscle strength is demonstrated in Table 4. Lower extremity muscle strength evaluation demonstrated a significant improvement in muscle strength of hip and knee musculature in the interventional group as compared to the control group.

Table 5 represents activity related numerical pain rating scores and effect size of participants in control and interventional groups. There was a significant reduction in pain scores for stair climbing in the interventional group as compared to the control group.

Table 6 represents WOMAC Scores and effect size of participants in control and interventional groups. There was no significant improvement in function pre and post intervention.

**Table 2: Muscle flexibility evaluation of participants in control and interventional group.**

| Variable | Control Group | | | | | | | | Interventional group | | | | | | | | P value | | Effect size | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tightness | Pre | | | | Post | | | | Pre | | | | Post | | | | | | | |
| | Mean | | SD | | Mean | | SD | | Mean | | SD | | Mean | | SD | | | | | |
| | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L |
| Obers test | 0.5 | 0.5 | 0.7 | 0.7 | 0.2 | 0.2 | 0.4 | 0.4 | 0.2 | 0.2 | 0.4 | 0.4 | 0 | 0 | 0.2 | 0.2 | 0 | 0 | 1.8 | 1.8 |
| Thomas test | 0.9 | 0.9 | 0.7 | 0.7 | 0.3 | 0.3 | 0.6 | 0.6 | 0.4 | 0.4 | 0.7 | 0.7 | 0.2 | 0.2 | 0.4 | 0.4 | 0.1 | 0.1 | 0.6 | 0.3 |
| Prone knee bending test | 0.8 | 0.8 | 0.8 | 0.8 | 0.3 | 0.3 | 0.5 | 0.5 | 0.4 | 0.4 | 0.5 | 0.5 | 0.2 | 0.2 | 0.4 | 0.4 | 0 | 0 | 0.3 | 0.2 |
| 90-90 hamstring test | 0.9 | 0.9 | 0.6 | 0.6 | 0.3 | 0.3 | 0.5 | 0.5 | 1.1 | 1.1 | 1.2 | 1.2 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.8 | 0.8 |

Paired t-test was used

**Table 3: Range of motion evaluation of participants in control and interventional group.**

| Variable | Control group | | | | | | | | Interventional group | | | | | | | | P value | | Effect size | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Range of motion | Pre | | | | Post | | | | Pre | | | | Post | | | | | | | |
| | Mean | | SD | | Mean | | SD | | Mean | | SD | | Mean | | SD | | | | | |
| | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L |
| Hip flexion | 73.24 | 73.4 | 20.1 | 21.4 | 76.2 | 77.32 | 20.1 | 19.19 | 81.92 | 84 | 23.5 | 24.5 | 91.64 | 91.36 | 22.1 | 24.4 | 0.8 | 0.23 | 0.2 | 1.2 |
| Hip Extension | 17.56 | 18.36 | 4.59 | 4.05 | 18.8 | 19.68 | 4.99 | 4.64 | 16.48 | 17.6 | 5.1 | 5.63 | 20.16 | 21.8 | 5.47 | 4.98 | 0.99 | 0.28 | 0.2 | 0.4 |
| Hip abduction | 33.28 | 33.72 | 7.85 | 8.99 | 36.2 | 37.44 | 7.51 | 7.26 | 32.8 | 34 | 6.86 | 7.36 | 35.96 | 37.88 | 6.07 | 6.29 | 0.2 | 0.46 | 0.09 | 0.06 |
| Knee flexion | 115.08 | 115.04 | 22.7 | 22.3 | 119.08 | 119.08 | 20.3 | 20.93 | 117.16 | 114.6 | 11.1 | 13.5 | 113.36 | 122.88 | 19.9 | 9.93 | 0.53 | 0.03 | 0.1 | 0.3 |
| Knee extension | 115.08 | 115.08 | 22.7 | 22.3 | 119.08 | 119.08 | 20.3 | 20.93 | 117.16 | 114.6 | 11.1 | 13.5 | 113.36 | 122.88 | 19.9 | 9.93 | 0.37 | 0.07 | 0.07 | 0.8 |

Paired t-test was used.

**Table 4: Evaluation of lower extremity muscle strength of participants in control and interventional group.**

| Variable | Control group | | | | | | | | Interventional group | | | | | | | | P value | | Effect size | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manual muscle testing | Pre | | | | Post | | | | Pre | | | | Post | | | | | | | |
| | Mean | | SD | | Mean | | SD | | Mean | | SD | | Mean | | SD | | | | | |
| | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L |
| Hip flexors | 7.6 | 7.48 | 0.91 | 0.77 | 8.64 | 8.56 | 0.95 | 0.96 | 7.68 | 7.68 | 1.14 | 1.21 | 8.56 | 8.56 | 0.65 | 0.76 | 0.04 | 0.18 | 0.1 | 0 |
| Hip extensors | 7.08 | 7.32 | 0.9 | 1.34 | 8.16 | 8.08 | 1.14 | 1.11 | 7.6 | 7.4 | 1.29 | 1.29 | 8.64 | 8.72 | 0.7 | 0.67 | 0.04 | 0.01 | 0.6 | 0.9 |
| Hip abductors | 7.28 | 7.44 | 0.98 | 0.96 | 8.44 | 8.48 | 1.19 | 1.04 | 7.72 | 7.76 | 1.2 | 1.33 | 8.8 | 8.72 | 0.57 | 0.61 | 0.01 | 0.01 | 0.7 | 0.4 |
| Knee flexors | 7.8 | 8.28 | 0.86 | 1.02 | 9.04 | 9 | 1.02 | 1.04 | 7.84 | 7.8 | 0.89 | 0.89 | 8.8 | 8.88 | 0.5 | 0.44 | 0.05 | 0.04 | 0.4 | 0.5 |
| Knee extensors | 8.28 | 8.4 | 1.02 | 1 | 9.04 | 9.12 | 1.09 | 1.01 | 8.48 | 8.7 | 0.87 | 0.9 | 9.08 | 9.08 | 0.49 | 0.49 | 0.01 | 0.01 | 0.1 | 0.1 |

Paired t-test was used

**Table 5: Numerical pain rating scores of participants in control and interventional groups.**

| Variable | Control group (n=25) | | | | Interventional group (n=25) | | | | P value | Effect size |
|---|---|---|---|---|---|---|---|---|---|---|
| Numerical pain rating scale | Pre | | Post | | Pre | | Post | | | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| Crossed leg sitting | 4.60 | 0.57 | 3.28 | 0.67 | 3.36 | 1.31 | 1.72 | 0.93 | 0.11 | 1.7 |
| Squatting | 4.64 | 0.49 | 3.28 | 0.67 | 3.44 | 1.04 | 1.88 | 0.97 | 0.34 | 0.5 |
| Stair climbing | 4.00 | 0.91 | 2.92 | 0.90 | 3.36 | 1.22 | 2.2 | 1.35 | 0.05 | 0.5 |
| Walking | 4.12 | 0.88 | 2.92 | 0.90 | 2.8 | 1.63 | 1.44 | 0.87 | 0.69 | 1.8 |

Paired t-test was used

**Table 6: WOMAC scores of participants in control and interventional groups.**

| Variables | Control group (n=25) | | | | Interventional group (n=25) | | | | P value | Effect size |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | | Post | | Pre | | Post | | | |
| WOMAC | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| Pain | 6.64 | 2.53 | 3.48 | 1.63 | 4.52 | 2.12 | 2.16 | 1.14 | 0.23 | 1.1 |
| Stiffness | 2.56 | 1.00 | 1.20 | 0.57 | 2.36 | 1.11 | 0.92 | 0.57 | 0.47 | 0.5 |
| ADL'S | 20.8 | 8.11 | 11.16 | 4.87 | 14.92 | 8.84 | 8.2 | 6.13 | 0.74 | 0.4 |
| Total | 29.28 | 11.06 | 15.84 | 6.43 | 22.32 | 10.69 | 11.28 | 6.96 | 0.96 | 0.6 |

Paired t-test was used

## DISCUSSION

Findings from the present study demonstrate yoga and conventional exercise to be effective as compared to conventional exercises for improving flexibility, muscle strength and joint motion in patients with knee osteoarthritis. There were significant improvements in muscle strength, muscle length, and joint motion in both the groups, but better results were obtained in intervention group. Numerical Pain Rating Scale and WOMAC Scale followed the same pattern of significant reduction in both groups over a period of 6 weeks, but on comparison no significant change was noted.

A study conducted by Bukowski, suggested an improvement in strength and flexibility of the patients suffering from osteoarthritis when compared to the patients in the no-exercise group.[13] Participants from intervention group demonstrated significant changes in flexibility as yoga asanas are known to passively stretch skeletal muscles, this influences the capsule and the deep ligaments of the joint, stimulates blood circulation around them and ensures their healthy condition.[2] Practicing yoga has been proven to improve joint flexibility and range of motion which are consistent with the findings of the present study.[14] This can be due to anatomical, biochemical, and physiological changes that are brought on by modifications in muscle and tendon length which will have an impact on the metabolism of soft tissues as well as the biomechanical function of joints. Clinical data also shows that intramuscular connective tissue may be responsible for a significant amount of the joint mobility restriction with ageing. Asanas improve awareness and stability, through co-contraction while holding the pose.[15] This can be due to the neurological effect of Golgi tendon organ (GTO) which are sensory organs that are situated close to the extrafusal muscle fibre-muscle tendon junction. During typical movement, they monitor changes in the tension of the muscular tendon units and send sensory data via Ib fibres with either passive stretching or active muscle contraction. The GTO activates, suppresses alpha motor neuron activity, and reduces tension in the muscle-tendon unit that is being stretched as tension builds up in a muscle. When a gradual stretch force is delivered to a muscle during yoga, the GTO activates and prevents muscular tension, enabling the muscle's parallel elastic component, the sarcomere, to stay relaxed and lengthened which improves flexibility.[15] Other benefits of holding yoga asanas for a long time is that the muscle spindle habituates and lessens its signals as you hold the muscle in a stretch position which also helps to improves flexibility.[16]

Muscle strengthening is the key component of exercises for osteoarthritis since muscle weakness is one of the major causes of pain and disability.[17] Osteoarthritis of knee affects the resting length of the surrounding muscles, according to the Length Tension Relationship, the natural resting length of the skeletal muscles maximizes the ability of the muscle to contract when stimulated. If the resting length is shorter (in case of tightness), contraction is compromised.[18] Thus the improvement in strength in the intervention group, could be due to the yoga asanas, that improved the flexibility of the muscles, thus allowing them to attain the natural resting length and optimizing the muscle contraction.

Loss of joint mobility is common in osteoarthritis. therefore, preserving range of motion is important for maintaining mobility.[19] As per the data collected for the present study (n=50) majority of the participants experienced left knee pain (table 10 - control group-48%, intervention group-56%) hence, major significant changes were seen in left knee joint range. This could be due to stretching which increases the stretch tolerance in turn improving the range of motion.[20] Knee osteoarthritis is characterized by progressive joint stiffness and muscle weakness thus, Strengthening and stretching is vital in increasing muscle length and power, that in turn may affect the joint motion. Hence, an improvement in the strength and flexibility of the periarticular structures around the knee joint may lead to an improvement in the knee joint motion with yoga and conventional exercises.

Findings from the present study report no significant change in pain using NPRS on comparing control and intervention group since the inclusion criteria limits pain <5 and no pain control protocol was followed, but upon comparing pre and post data of individual groups using paired-t test there was a notable change in pain levels. Reduction of pain levels in control group could be the effect of conventional exercises which increases mitochondrial quantity, which in turn increases ATP production. Collagen and proteoglycan production are stimulated, increasing the structural strength. Improvement in function and a decrease in limitation are results of pain relief.[21,22] In contrast, reduction of pain in intervention group could be due to yoga therapy which may boost the proteoglycan content of cartilage and stop cartilage degradation. This helps to strengthen the periarticular muscles (such as the quadriceps and hamstrings) that contract to stabilize the painful knee joint. Yoga practice could prevent the decline of synovial fluid volume by strengthening and stretching various body parts, delivering new blood to the internal organs, revitalizing the nervous system, and lubricating the joints, muscles, and ligaments.[2] Reduction in pain could also be due to neurological effect where lower motor neurons will get fewer nerve impulses per second when an inhibitory upper motor neuron's activity is reduced in the cerebral cortex, which will aid in relaxing the skeletal muscles. Shavasana's conscious relaxation aids in the activation of inhibitory pathways; if an inhibitory neuron begins firing higher-than-normal numbers of nerve impulses per second to the lower motor neurons, it will help silence the motor neuron on its own, resulting in muscular relaxation and pain alleviation.[15] Yoga differs from physical exercises given that it emphasizes the proper alignment of the body in space both at rest and during movement. This is achieved through introspective body awareness. The stress-reducing effect of yoga seems to be another key factor in its effectiveness in pain management.[17]

When performing the fundamental daily tasks, such as walking, the normal knee flexes to varying degrees, ranging from about 70° to more than 90° when using stairs and sitting on chairs. 105° to 110° flexion is required for simple stair descending and getting out of a chair. However, many Eastern, Western and Asian cultures consider these postures to be fundamental to daily life.[23] Functional scale WOMAC showed no significant difference on comparison between the two groups. As a relatively longer period of yoga intervention may help to improve functional activities in patients with knee osteoarthritis. But when compared individually, there was a significant change in functional scores in both the groups. Pain and stiffness are symptoms that can have a number of negative effects on quality of life, including restricted mobility. Yoga exercise has been shown to reduce pain and increase muscular strength, both of which support the idea that yoga may improve mobility.[24]

This study has few limitations. The sample size of the study is small. The scores for rating pain were assessed using the Numerical pain rating scale which is a subjective measure and would vary from patient to patient for activities like crossed leg sitting, walking, squatting and stair climbing.

## CONCLUSION

Findings from present study report yoga practice improves knee flexion range of muscle, muscle strength and flexibility in patients with knee osteoarthritis.

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