

Original Research

Received 25 May 2026

Revised 20 July 2026

Accepted 01 August 2026

Natural Resources for Human Health 2026, Vol. 6 (14s): 156–167

KEYWORDS:

Knee osteoarthritis, Kinesiophobia, Maitland mobilization, Myofascial release, Pain, Tampa Scale for Kinesiophobia, WOMAC

Efficacy of Maitland Mobilization and Myofascial Release Technique in Patients with knee osteoarthritis: A Randomized Controlled Trial

¹Pooja Kumari, ²Chanchal Jain, ³Jyoti Kataria

¹ MPT (Musculoskeletal) Student, Banarsidas Chandiwal Institute of Physiotherapy, New Delhi, India poojakri26@gmail.com

²Assistant Professor, Banarsidas Chandiwal Institute of Physiotherapy, New Delhi, India jainchanchal81@gmail.com

³Associate Professor, Banarsidas Chandiwal Institute of Physiotherapy, New Delhi, India dahiya.jyoti25@gmail.com

Corresponding author: Pooja Kumari, poojakri26@gmail.com

ABSTRACT:

Background

Knee osteoarthritis (OA) is a common musculoskeletal condition characterized by pain, joint stiffness, restricted range of motion (ROM), and functional limitations. Manual therapy techniques, including Maitland mobilization and myofascial release (MFR), are commonly used in physiotherapy to address these impairments. This study evaluated the effects of combined Maitland mobilization and MFR on pain, knee ROM, functional disability, and kinesiophobia in patients with knee OA.

Materials & Methods

A comparative interventional study was conducted among 36 patients with knee OA, with 18 participants allocated to each group. Group A received combined Maitland mobilization and MFR, whereas Group B received the comparator intervention according to the study protocol. Pain intensity was assessed using the Visual Analogue Scale (VAS), knee mobility was evaluated by measuring flexion and extension ROM, functional disability was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and kinesiophobia was evaluated using the Tampa Scale for Kinesiophobia (TSK). Assessments were performed before and after the intervention, with the final assessment conducted on Day 14. Within-group changes were analyzed using paired t-tests.

Results

The mean VAS score decreased from 7.11 at baseline to 2.83 after treatment in Group A and from 7.11 to 5.11 in Group B. In Group A, the reduction in VAS score was statistically significant ($t = -16.821$, $df = 17$, $p < 0.001$). At Day 14, the mean knee flexion was $117.7 \pm 2.94^\circ$ in Group A and $107.9 \pm 2.49^\circ$ in Group B, while the mean knee extension values were $3.27 \pm 1.22^\circ$ and $6.33 \pm 1.18^\circ$, respectively. The reported paired t-test analyses for knee flexion and extension in Group A demonstrated statistically significant changes ($p < 0.001$). Mean WOMAC scores decreased from 64.30 to 37.50 in Group A and from 65.30 to 52.90 in Group B. Mean TSK scores decreased from 45.50 to 31.50 in Group A and from 46.90 to 41.90 in Group B. The reported paired analysis demonstrated a statistically significant reduction in TSK scores ($t =$

−21.678, $p < 0.001$).

Conclusion

Combined Maitland mobilization and MFR was associated with improvements in pain, knee ROM, functional disability, and kinesiophobia over the 14-day intervention period. Greater numerical reductions in VAS, WOMAC, and TSK scores were observed in Group A than in Group B. However, as the reported statistical analyses primarily assessed within-group changes, these findings do not establish whether the magnitude of improvement differed significantly between the two groups. Appropriate between-group analyses are required to determine the statistical significance of differences in treatment effects. Further studies involving larger samples and longer follow-up periods are recommended.

Introduction

Osteoarthritis (OA) is a chronic, progressive musculoskeletal disorder characterized by structural and functional alterations involving the entire joint, including the articular cartilage, subchondral bone, synovium, menisci, ligaments, and periarticular tissues. Knee OA is an important cause of pain, mobility limitation, and disability, particularly among middle-aged and older adults. The global burden of knee OA has increased substantially over recent decades. According to estimates from the Global Burden of Disease Study 2019, approximately 364.6 million people were living with knee OA worldwide in 2019, with the prevalence increasing with advancing age and being higher among women than men [1]. In India, the burden of knee OA also varies considerably across populations because of differences in age distribution, sex, occupational exposure, body mass index, diagnostic criteria, and geographical characteristics. A recent systematic review and meta-analysis of population-based studies estimated a pooled prevalence of approximately 20.24% for knee OA in India, although substantial heterogeneity was observed among the included studies [2].

The development of knee OA is multifactorial and involves an interaction between mechanical, metabolic, biological, and patient-related factors. Advancing age, female sex, obesity, previous knee injury, occupational loading, muscle weakness, and structural abnormalities have been associated with an increased risk of disease development or progression [3]. Pathological changes may include progressive cartilage degradation, subchondral bone remodeling, osteophyte formation, synovial alterations, and changes in periarticular soft tissues. These abnormalities may manifest clinically as pain, joint stiffness, tenderness, crepitus, swelling, and restricted movement. Quadriceps weakness is also frequently observed in individuals with knee OA and may contribute to impaired joint stability and functional performance [4]. Limitations in activities such as walking, stair climbing, squatting, and transitional movements can subsequently affect independence and quality of life.

Radiographic severity of knee OA is commonly assessed using the Kellgren–Lawrence (K-L) grading system. The system categorizes radiographic findings from grade 0, indicating the absence of radiographic abnormalities, to grade 4, representing severe OA with marked joint-space narrowing, large osteophytes, substantial subchondral sclerosis, and definite bony deformity. The K-L classification provides a standardized method for describing the structural severity of radiographic OA and is frequently used in clinical and research settings [5]. However, radiographic severity does not always correspond directly with the intensity of pain or functional limitation, emphasizing the importance of evaluating both structural and patient-reported outcomes.

Pain is one of the principal symptoms associated with knee OA and is a major reason for seeking medical and rehabilitative care. In addition to pain, stiffness, reduced knee range of motion (ROM), muscle weakness, and impaired physical function may contribute substantially to disability. Consequently, contemporary management of knee OA emphasizes symptom control, maintenance or improvement of physical function, and promotion of long-term physical activity. Conservative management may include patient education, therapeutic exercise, weight management when appropriate, physical activity, and individualized rehabilitation interventions [6]. Physiotherapy therefore plays an important role in the non-surgical management of knee OA, with treatment directed toward reducing symptoms, improving mobility, enhancing muscular function, and facilitating participation in daily activities [7].

Manual therapy is frequently incorporated into physiotherapy programs as an adjunct to exercise and other rehabilitation strategies. Maitland mobilization is a manual therapy approach involving graded passive oscillatory movements applied to a joint according to the patient's symptoms, irritability, and movement restriction. It is used clinically to reduce pain, improve accessory joint movement, decrease stiffness, and facilitate functional mobility. Proposed effects include both mechanical and neurophysiological responses, although the magnitude and duration of these effects may vary according to the mobilization technique, treatment dosage, and characteristics of the individual patient [8].

Maitland mobilization may be applied to the tibiofemoral and patellofemoral joints using different grades and directions according to the clinical objective. Techniques directed toward restricted accessory movement may be used to facilitate knee flexion or extension and improve patellar mobility. Clinical studies have reported short-term improvements in pain and selected measures of physical function following Maitland mobilization in individuals with knee OA [8, 9]. However, manual mobilization should generally be considered as part of a broader rehabilitation program rather than as an isolated treatment strategy.

Myofascial release (MFR) is a manual soft-tissue technique intended to address restrictions or altered mobility within the myofascial system through sustained or controlled pressure and tissue loading. Fascia forms a continuous connective-tissue network associated with muscles and other anatomical structures. Changes in soft-tissue mobility, muscle tension, or local tissue sensitivity may influence movement and contribute to musculoskeletal symptoms. MFR is therefore used clinically with the objective of improving soft-tissue mobility, reducing pain, and facilitating movement [10]. The proposed mechanisms of MFR include alterations in tissue mechanical properties and modulation of sensory input; however, the precise physiological mechanisms underlying its clinical effects remain incompletely established.

Evidence concerning the use of MFR in individuals with knee OA has increased, with studies reporting potential improvements in pain, ROM, and functional performance. However, treatment protocols, application techniques, duration, and outcome measures vary considerably between studies, making it difficult to establish the independent contribution of MFR to clinical improvement [11]. Similarly, although Maitland mobilization has demonstrated beneficial short-term effects on pain and functional outcomes in patients with knee OA, evidence regarding its combination with MFR remains comparatively limited [8,9]. This creates a clinically relevant need to investigate whether combining joint mobilization with soft-tissue techniques can provide meaningful improvements across multiple domains of knee OA.

In addition to pain and physical function, functional disability and fear of movement are important considerations in patients with knee OA. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a validated disease-specific instrument widely used to assess pain, stiffness, and physical function in individuals with knee and hip OA [12]. Kinesiophobia, defined as an excessive or persistent fear of movement or reinjury, may further influence activity levels and functional performance in individuals with musculoskeletal pain. The Tampa Scale for Kinesiophobia (TSK) is a validated questionnaire commonly used to assess fear of movement and reinjury in patients with musculoskeletal disorders [13].

Assessment of this psychological component may provide additional information regarding functional status and response to rehabilitation. Although Maitland mobilization and MFR have each been investigated as therapeutic approaches for musculoskeletal disorders, evidence regarding their combined application in patients with knee OA remains limited, particularly when multiple clinical outcomes are evaluated simultaneously. Therefore, the present study was undertaken to evaluate the effects of combined Maitland mobilization and MFR in patients with knee OA. The study specifically assessed changes in pain intensity, knee flexion and extension ROM, WOMAC scores, and kinesiophobia measured using the TSK following the intervention.

MATERIALS & METHODS

Study Design and Ethical Considerations

A comparative, repeated-measures clinical study was conducted at Banarsidas Chandiwala Institute of Physiotherapy, New Delhi, to compare the effects of Maitland mobilization combined with MFR with those of conventional physiotherapy in patients with knee OA.

The study protocol was reviewed and approved by the Banarsidas Chandiwala Institutional Ethics Committee (Approval No. BPT/MPT MS/EC/2024/003). The study was registered with the Clinical Trials Registry–India (CTRI) under registration

number CTRI/2025/05/0106058. The study procedures were explained to all eligible participants, and written informed consent was obtained from each participant before enrollment.

Sample Size

The sample size was calculated using G*Power software, version 3.1.9.7. The calculation was based on an effect size of 0.25, a significance level of $\alpha = 0.05$, and a statistical power of 95%. The calculated total sample size was 36 participants. Accordingly, 36 participants were included and allocated equally into two groups, with 18 participants in each group.

Sampling and Random Allocation

Participants fulfilling the predefined eligibility criteria were recruited for the study. Eligible participants were randomly allocated into two intervention groups:

- **Group A (n = 18):** Maitland mobilization combined with MFR
- **Group B (n = 18):** Conventional physiotherapy

The same assessment and treatment schedule was followed for both groups throughout the study period.

Inclusion Criteria

Participants were included if they fulfilled the following criteria:

- Male and female patients aged 40–70 years
- Patients with knee OA diagnosed by a physician or orthopaedician
- Patients diagnosed with Grade I or Grade II knee OA according to the Kellgren–Lawrence grading system
- Patients presenting with clinical features of knee OA, including pain on patellofemoral compression, crepitus, periarticular or joint-line tenderness, swelling, and restricted knee ROM at baseline
- Patients able to walk a short distance independently or with the assistance of a walking aid
- Patients with unilateral or bilateral knee OA

Exclusion Criteria

Participants were excluded if they had:

- A history of previous knee surgery or significant knee injury
- A co-existing neurological condition that could affect lower-limb function or study outcomes
- Osteoporosis, systemic illness, or metabolic disorders that could interfere with treatment or assessment
- Dermatological disease or skin lesions over the treatment area that could contraindicate the planned intervention

Intervention Protocol

The intervention was administered over a 14-day treatment period. Participants underwent baseline assessment before commencement of treatment (T0) and a final assessment on Day 14 (T1). The same assessment procedures were followed at both time points.

Group A: Maitland Mobilization and MFR

Participants in Group A received a combination of Maitland joint mobilization and MFR techniques.

Maitland Mobilization

Techniques were selected according to the participant's clinical presentation and treatment objective. Grades I and II mobilizations were primarily used for pain relief, whereas Grades III and IV mobilizations were used to improve restricted

joint ROM. Each manual technique was administered for 2–6 bouts of 30 seconds, according to participant tolerance and clinical requirement.

Tibiofemoral Joint Mobilization

The following tibiofemoral mobilization techniques were performed:

1. **Tibiofemoral distraction** to facilitate pain reduction and improve joint mobility
2. **Tibiofemoral posterior glide** to facilitate improvement in knee flexion
3. **Tibiofemoral anterior glide** to facilitate improvement in knee extension

The participant was positioned supine with the knee comfortably supported in a few degrees of flexion using a soft pillow. The therapist stabilized the joint appropriately and applied the mobilization in the desired direction.

Patellofemoral Joint Mobilization

Patellofemoral mobilization consisted of:

- Medial glide
- Lateral glide
- Superior (cephalic) glide
- Inferior (caudal) glide

The participant was positioned supine with the knee slightly flexed to facilitate optimal access to the patella. The mobilizations were performed within the participant's tolerable range to maintain or improve patellar mobility and facilitate knee movement.

MFR Technique

It was performed over the iliotibial band, hamstrings, and quadriceps muscles. Areas of increased muscle tension or palpable myofascial restriction were identified by manual palpation before treatment. Each MFR stroke was maintained for approximately 30 seconds and repeated five times per treatment session. Pressure was gradually applied and adjusted according to participant tolerance.

Iliotibial Band

The participant was positioned in side-lying with the affected limb uppermost. Longitudinal strokes were applied along the iliotibial band using the therapist's thumb or elbow. Moderate, tolerable pressure was applied over the taut tissue without producing excessive discomfort.

Hamstrings

The participant was positioned prone with the affected limb relaxed. MFR was performed using the ulnar border of the therapist's hand, with strokes directed from proximal to distal along the hamstring musculature. Light-to-moderate pressure was applied until the perceived soft-tissue restriction was reduced.

Quadriceps

The participant was positioned supine with the quadriceps relaxed. The therapist used the elbow to apply sliding compression, beginning at the distal quadriceps and progressing toward the proximal portion of the muscle. Pressure was adjusted according to tissue resistance and participant tolerance.

Group B: Conventional Physiotherapy

Participants in Group B received conventional physiotherapy consisting of thermotherapy, transcutaneous electrical nerve stimulation (TENS), strengthening exercises, stretching exercises, and ergonomic advice.

1. Thermotherapy

Moist heat therapy was applied to the affected knee for 10 minutes to assist in pain reduction and prepare the tissues for therapeutic exercise.

2. TENS

TENS was administered around the affected knee using four self-adhesive electrodes positioned in a crossed configuration. The stimulation frequency was set at 50 Hz, and treatment was administered for 10 minutes.

3. Strengthening Exercises

The strengthening exercise program consisted of:

- Static quadriceps contractions
- Dynamic quadriceps exercises
- Static hamstring contractions
- Vastus medialis obliquus (VMO) strengthening

Each contraction was maintained for 6 seconds, followed by a 10-second rest interval, and 10 repetitions were performed for each exercise. The strengthening exercises were performed daily during the intervention period.

4. Stretching Exercises

Stretching exercises were performed for the:

- Quadriceps
- Hamstrings
- Calf muscles

Each stretch was maintained for 30 seconds and repeated three times. The stretching exercises were performed daily during the intervention period.

5. Ergonomic Advice

Participants received standardized ergonomic advice regarding knee protection and activities of daily living. They were advised to avoid activities or positions that aggravated knee pain, minimize excessive loading of the knee joint, use appropriate body mechanics, and follow safe strategies during functional activities and ambulation.

Outcome Measures

Outcome assessment was performed at two predefined time points:

T0 (Baseline): Assessment performed before initiation of the intervention

T1 (Day 14): Final assessment performed after completion of the 14-day intervention period

The following outcome measures were assessed:

Primary Outcome

Pain intensity: Pain was assessed using the Visual Analogue Scale (VAS). Participants were asked to indicate their perceived level of knee pain on the standardized scale.

Secondary Outcomes

The secondary outcomes included:

- **Knee ROM:** Knee flexion and extension were assessed using a standardized clinical measurement procedure.

- **WOMAC:** Used to assess pain, stiffness, and physical functional limitation associated with knee OA.
- **TSK:** Used to assess fear of movement or reinjury associated with musculoskeletal pain.

For participants with bilateral knee OA, the more symptomatic knee at baseline was designated as the index knee for clinical outcome assessment and was assessed consistently at subsequent time points. The same assessor and standardized assessment procedures were used at T0 and T1 to minimize measurement variability.

Statistical Analysis

Data were analyzed using appropriate statistical procedures for continuous and categorical variables. Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were summarized as frequencies and percentages. The changes in outcome measures between baseline (T0) and Day 14 (T1) were assessed using paired-samples t-tests for within-group comparisons. Between-group differences in changes from baseline to Day 14 were assessed using an independent-samples t-test, where the assumptions for parametric analysis were satisfied. The level of statistical significance was set at $p < 0.05$. All statistical tests were two-tailed.

RESULTS

Demographic Characteristics

The demographic profile of the study participants was assessed according to gender distribution in Groups A and B. Each group comprised 18 patients, resulting in a total sample of 36 patients. In Group A, 5 patients (28%) were male and 13 patients (72%) were female, indicating a higher proportion of female participants. In Group B, 10 patients (56%) were male and 8 patients (44%) were female. Thus, Group B had a relatively greater proportion of male participants compared with Group A. Overall, females constituted the larger proportion of participants in Group A, whereas males were more frequently represented in Group B. The gender distribution of the study population is presented in Table 1.

Table 1: Patients Distribution at Gender & Group Level

Patient Gender	Group A		Group B	
	Frequency	Percent	Frequency	Percent
Male	5	28%	10	56%
Female	13	72%	8	44%
Total	18	100%	18	100%

2. VAS

Table 2 presents the group-wise mean VAS scores recorded before and after the intervention. Both Group A and Group B had an identical mean baseline VAS score of 7.11. Following the intervention, the mean VAS score decreased to 2.83 in Group A and 5.11 in Group B. Thus, the reduction in mean VAS score was greater in Group A (4.28 points) than in Group B (2.00 points), indicating a greater reduction in pain intensity in Group A based on the observed mean values.

Table 2: Group wise Mean values of VAS Score

VAS Post	Mean Values	
	Pre	Post
Group A	7.11	2.83
Group B	7.11	5.11

Table 3 presents the paired comparison of VAS scores in Group A between Day 1 and Day 14. The analysis demonstrated a statistically significant change in pain intensity following the intervention, with a paired t -value of -16.821 at 17 degrees of freedom and $p < 0.05$. The findings indicate a significant reduction in knee pain from baseline to Day 14 among patients who received the combined Maitland Mobilization and MFR intervention. Therefore, the results support a significant within-group improvement in pain intensity in Group A over the 14-day treatment period.

Table 3: Paired t -Test for knee pain in patients on Day 1

VAS Pre	Descriptive Analytics		Paired t -test		
	Mean $\pm$ SD	N	t	df	Sig.
Group A	7.11 $\pm$ 0.75	18	0.000	17	1.000
Group B	7.11 $\pm$ 0.75	18			

3. ROM

Table 4 presents the post-intervention knee ROM findings for Groups A and B. In Group A, the mean knee flexion at Day 14 was $117.7 \pm 2.94^\circ$. The paired t -test revealed a t -value of 16.075 with 17 degrees of freedom (df) and $p < 0.001$, indicating a statistically significant change in knee flexion from baseline to Day 14. The mean knee extension in Group A at Day 14 was $3.27 \pm 1.22^\circ$. The paired t -test demonstrated a t -value of -12.280 with 17 degrees of freedom and $p < 0.001$, indicating a statistically significant change in knee extension from baseline to Day 14. In Group B, the mean knee flexion at Day 14 was $107.9 \pm 2.49^\circ$. However, the corresponding paired t -test statistic and p -value for Group B were not reported in the provided table. Consequently, the statistical significance of the within-group change in Group B cannot be established from the available results. Overall, Group A showed statistically significant changes in both knee flexion and extension by Day 14. The mean post-intervention knee flexion was higher in Group A (117.7°) than in Group B (107.9°). However, this numerical difference should not be interpreted as a statistically significant between-group difference unless supported by an appropriate independent between-group analysis.

Table 4: Paired t -Test for knee ROM on Day 14

ROM		Descriptive Analytics		Paired t -test		
		Mean $\pm$ SD	N	t	df	Sig.
Flexion Post	Group A	117.7 $\pm$ 2.94	18	16.075	17	0.000
	Group B	107.9 $\pm$ 2.49	18			
Extension Post	Group A	3.27 $\pm$ 1.22	18	-12.280	17	0.000
	Group B	6.33 $\pm$ 1.18	18			

4. WOMAC

Table 5 presents the group-wise mean WOMAC scores recorded before and after the intervention. In Group A, the mean

WOMAC score decreased from 64.30 at baseline to 37.50 post-intervention, representing a reduction of 26.80 points. In Group B, the mean score decreased from 65.30 to 52.90, corresponding to a reduction of 12.40 points.

Table 5: Group wise Mean values of WOMAC Score

Disability In Patients		Mean Values	
		Pre	Post
WOMAC	Group A	64.30	37.50
	Group B	65.30	52.90

5. TAMPA

Table 6 presents the group-wise mean scores on the TSK before and after the intervention. The TSK was used to assess fear of movement associated with knee OA. In Group A, the mean Tampa Scale score decreased from 45.50 at baseline to 31.50 after the intervention, representing a reduction of 14.00 points. In Group B, the mean score decreased from 46.90 to 41.90, representing a reduction of 5.00 points. Thus, both groups demonstrated a reduction in kinesiophobia following treatment, with a greater numerical reduction observed in Group A. The paired *t*-test demonstrated a *t*-value of -21.678 , indicating a statistically significant change in Tampa Scale scores, with $p < 0.001$. Therefore, the reduction in kinesiophobia was statistically significant. Overall, the findings indicate that the intervention was associated with a significant reduction in fear of movement among patients with knee OA. The greater reduction in the mean Tampa Scale score observed in Group A suggests a substantial improvement in kinesiophobia following the intervention. These findings indicate that, in addition to improvements in pain and physical function, the intervention may contribute to reducing psychological barriers related to movement in patients with knee OA.

Table 6: Group wise Mean values of Tampa Score

Disability In Patients		Mean Values	
		Pre	Post
Tampa	Group A	45.50	31.50
	Group B	46.90	41.90

DISCUSSION

The present study evaluated the effectiveness of Maitland mobilization combined with MFR technique in patients with knee OA, using VAS, knee ROM, WOMAC, and the Tampa Scale for Kinesiophobia. Overall, the combined intervention produced greater improvements in pain, mobility, functional status, and kinesiophobia than the comparison intervention.

Baseline Characteristics

Both groups included 18 participants and were generally comparable at baseline. Mean age was 55.4 years in Group A and 51.8 years in Group B. Although sex distribution differed between groups, baseline VAS, knee flexion, extension, and WOMAC scores showed no significant differences, supporting overall comparability. However, Tampa Scale scores differed significantly at baseline ($p = 0.011$), with greater kinesiophobia in Group B. This baseline imbalance should therefore be considered when interpreting changes in kinesiophobia.

Effect on Pain

Pain decreased significantly following treatment, with a greater improvement in Group A receiving Maitland mobilization combined with MFR. Deyle et al. (2005) [14] reported beneficial effects of manual therapy combined with supervised exercise

in patients with knee OA. Similarly, Abbott et al. (2013) [15] demonstrated clinical benefits of manual therapy and exercise in individuals with hip or knee OA. The greater pain reduction in Group A may reflect the complementary effects of joint mobilization and soft-tissue treatment. Maitland mobilization may improve joint mobility and modulate nociceptive input, while MFR may reduce myofascial restriction and soft-tissue tension. These combined effects may contribute to improved pain and movement tolerance. Alkhawajah and Alshami (2019) [16] also reported significant improvements in pain and function following mobilization-based treatment, while Nigam et al. (2021) [17] demonstrated sustained benefits of mobilization with movement in knee OA.

Effect on Knee ROM

Significant improvements in knee mobility were observed, particularly in Group A. Flexion increased from 100.4° to 117.7° in Group A compared with 99.6° to 107.9° in Group B. Extension lag decreased from 9.11° to 3.27° in Group A and from 9.27° to 6.33° in Group B. These findings suggest that combining joint mobilization with MFR may improve both joint and soft-tissue mobility. Maitland mobilization may facilitate accessory joint movement, whereas MFR may improve the extensibility of surrounding muscles and fascial tissues. The findings are consistent with Deyle et al. (2005) [14], who demonstrated improved physical function following a manual therapy-based physical therapy program.

Functional Outcome

WOMAC scores improved substantially, decreasing from 64.3 to 37.5 in Group A and from 65.3 to 52.9 in Group B. The greater reduction in Group A indicates improved pain, stiffness, and functional ability following the combined intervention. Abbott et al. (2013) [15] similarly reported clinical benefits from manual therapy and exercise in patients with hip or knee OA. Improvement in pain and ROM may have facilitated daily activities and functional participation. Furthermore, increased movement confidence following symptom reduction may have contributed to improved functional performance. Heisig et al. (2025) [18] emphasized the importance of adherence-support strategies in physical activity interventions for individuals with chronic musculoskeletal pain, highlighting the relevance of maintaining activity as part of long-term management.

Effect on Kinesiophobia

Tampa Scale scores decreased from 45.5 to 31.5 in Group A and from 46.9 to 41.9 in Group B, indicating reduced fear of movement following treatment. The larger reduction in Group A may be related to concurrent improvements in pain and mobility. However, because Tampa scores differed significantly at baseline ($p = 0.011$), this finding should be interpreted cautiously. Reduced pain and improved movement may increase patients' confidence in using the affected limb and participating in physical activity. This is clinically relevant because persistent fear of movement can contribute to activity avoidance and functional limitation. The findings are therefore consistent with the broader emphasis on facilitating physical activity in chronic musculoskeletal conditions reported by Heisig et al. (2025) [16]. Overall, Maitland mobilization combined with MFR was associated with greater improvements in pain, knee ROM, WOMAC scores, and kinesiophobia than the comparison intervention. These findings are broadly consistent with previous evidence supporting manual therapy as part of conservative management for knee OA. The observed improvements may reflect the combined effects of enhanced joint mobility and reduced periarticular soft-tissue restriction. However, the small sample size and baseline difference in kinesiophobia should be considered when interpreting the results. Future studies with larger samples, standardized treatment protocols, and longer follow-up are warranted to determine the durability and generalizability of these findings.

LIMITATIONS

The present study has several limitations that should be considered when interpreting its findings. First, the sample size was relatively small, with only 36 participants, which may limit the statistical power and generalizability of the findings to the broader population with KO. Second, the intervention period was limited to 14 days, and therefore the study could not determine whether the observed improvements were sustained over the longer term. Third, the study included only patients with Grade I and Grade II KO, limiting the applicability of the findings to patients with more advanced disease. Fourth, although both unilateral and bilateral knee OA were permitted, the assessment was based on a designated index knee, which may not fully represent the functional status of patients with bilateral involvement. Fifth, the study did not include a long-term follow-up assessment; consequently, the persistence of treatment effects after completion of the intervention remains uncertain. Finally, some of the outcome measures, particularly pain and kinesiophobia, were based on patient-reported

responses and may therefore be influenced by individual perception and response variability.

Future recommendations

Future studies should include larger sample sizes and participants from multiple physiotherapy or healthcare centers to improve the generalizability of the findings. Longer intervention periods and extended follow-up assessments should be incorporated to determine whether the benefits of Maitland mobilization combined with MFR are maintained over time. Future research should also evaluate patients with different radiographic grades of knee OA to determine whether treatment response varies according to disease severity. Further randomized controlled trials with clearly described allocation procedures and assessor blinding should be conducted to strengthen the evidence regarding the comparative effectiveness of these interventions. Future studies may also investigate different treatment frequencies, session durations, and combinations of manual therapy and exercise. In addition, objective functional measures, patient-reported quality-of-life measures, and biomechanical or physical-performance outcomes may be incorporated to provide a more comprehensive evaluation of treatment effects. Comparative studies with longer follow-up periods may further clarify the role of Maitland mobilization and MFR in the long-term conservative management of knee OA.

CONCLUSION

Maitland mobilization combined with MFR was associated with improvements in pain, knee ROM, and kinesiophobia in patients with Grade I and II KO. The findings suggest that this combined manual therapy approach may be a beneficial component of conservative physiotherapy management for knee OA.

Conflicts of Interest: Nil

Financial Support: None

REFERENCES

- [1] Cui A, Li H, Wang D, Zhong J, Chen Y, Lu H. Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. *EClinicalMedicine*. 2020 Nov 26;29-30:100587. doi: 10.1016/j.eclinm.2020.100587. PMID: 34505846; PMCID: PMC7704420.
- [2] Hazra S, Mondal K, Bhattacharya D, Handa G. Prevalence of Knee Osteoarthritis in India: A Systematic Review and Meta-Analysis of Population-Based Studies. *Indian J Orthop*. 2025 Aug 15;59(11):1785-1796. doi: 10.1007/s43465-025-01520-4. PMID: 41245277; PMCID: PMC12615881.
- [3] Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. *Lancet*. 2019 Apr 27;393(10182):1745-1759. doi: 10.1016/S0140-6736(19)30417-9. PMID: 31034380.
- [4] Culvenor AG, Ruhdorfer A, Juhl C, Eckstein F, Øiestad BE. Knee Extensor Strength and Risk of Structural, Symptomatic, and Functional Decline in Knee Osteoarthritis: A Systematic Review and Meta-Analysis. *Arthritis Care Res (Hoboken)*. 2017 May;69(5):649-658. doi: 10.1002/acr.23005. PMID: 27563843.
- [5] KELLGREN JH, LAWRENCE JS. Radiological assessment of osteo-arthritis. *Ann Rheum Dis*. 1957 Dec;16(4):494-502. doi: 10.1136/ard.16.4.494. PMID: 13498604; PMCID: PMC1006995.
- [6] Bannuru RR, Osani MC, Vaysbrot EE, Arden NK, Bennell K, Bierma-Zeinstra SMA, Kraus VB, Lohmander LS, Abbott JH, Bhandari M, Blanco FJ, Espinosa R, Haugen IK, Lin J, Mandl LA, Moilanen E, Nakamura N, Snyder-Mackler L, Trojian T, Underwood M, McAlindon TE. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis Cartilage*. 2019 Nov;27(11):1578-1589. doi: 10.1016/j.joca.2019.06.011. Epub 2019 Jul 3. PMID: 31278997.
- [7] Zhang L, Wang Y, Ye T, Hu Y, Wang S, Qian T, Wu C, Yue S, Sun X, Zhang Y. Quality of clinical practice guidelines relevant to rehabilitation of knee osteoarthritis: A systematic review. *Clin Rehabil*. 2023 Jul;37(7):986-1008. doi: 10.1177/02692155221144892. Epub 2022 Dec 20. PMID: 36540949.

- [8] Pozsgai M, Péter IA, Farkas N, Than P, Nusser N. End-range Maitland mobilization decreasing pain sensitivity in knee osteoarthritis: randomized, controlled clinical trial. *Eur J Phys Rehabil Med.* 2022 Jun;58(3):442-451. doi: 10.23736/S1973-9087.22.06680-1. Epub 2022 Jan 5. PMID: 34985236; PMCID: PMC9980501.
- [9] Bhagat M, Neelapala YVR, Gangavelli R. Immediate effects of Mulligan's techniques on pain and functional mobility in individuals with knee osteoarthritis: A randomized control trial. *Physiother Res Int.* 2020 Jan;25(1):e1812. doi: 10.1002/pri.1812. Epub 2019 Sep 10. PMID: 31502354.
- [10] Farshchi F, Farshchi N, Abdi Hamzeh Kalayi R. The role of myofascial release techniques as an adjunct to other therapies in knee osteoarthritis: a systematic review. *Health Sci Rep.* 2025;8(11). doi:10.1002/hsr2.71507.
- [11] Nouman M, Shabnam J, Anwar S, Perveen W, Alexe DI, Sánchez-Gómez R, Sava MA, Alexe CI. Effect of Iliotibial Band Myofascial Release Combined with Valgus Correction Exercise on Pain, Range of Motion, Balance, and Quality of Life in Patients with Grade II Knee Osteoarthritis: A Randomized Clinical Trial. *Life (Basel).* 2024 Oct 27;14(11):1379. doi: 10.3390/life14111379. PMID: 39598178; PMCID: PMC11595761.
- [12] Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol.* 1988 Dec;15(12):1833-40. PMID: 3068365.
- [13] Vlaeyen JWS, Kole-Snijders AMJ, Boeren RGB, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. *Pain.* 1995 Sep;62(3):363-372. doi: 10.1016/0304-3959(94)00279-N. PMID: 8657437. Sharma, Harish & Kashif, Reza. (2013). Effect of Maitland Mobilization and Myofascial Release Technique in Patients with Knee Osteoarthritis. *Indian Journal of Physiotherapy and Occupational Therapy - An International Journal.* 7. 181. 10.5958/j.0973-5674.7.4.145.
- [14] Deyle GD, Allison SC, Matekel RL, Ryder MG, Stang JM, Gohdes DD, Hutton JP, Henderson NE, Garber MB. Physical therapy treatment effectiveness for osteoarthritis of the knee: a randomized comparison of supervised clinical exercise and manual therapy procedures versus a home exercise program. *Phys Ther.* 2005 Dec;85(12):1301-17. PMID: 16305269.
- [15] Abbott JH, Robertson MC, Chapple C, Pinto D, Wright AA, Leon de la Barra S, Baxter GD, Theis JC, Campbell AJ; MOA Trial team. Manual therapy, exercise therapy, or both, in addition to usual care, for osteoarthritis of the hip or knee: a randomized controlled trial. 1: clinical effectiveness. *Osteoarthritis Cartilage.* 2013 Apr;21(4):525-34. doi: 10.1016/j.joca.2012.12.014. Epub 2013 Jan 8. PMID: 23313532.
- [16] Alkhawajah HA, Alshami AM. The effect of mobilization with movement on pain and function in patients with knee osteoarthritis: a randomized double-blind controlled trial. *BMC Musculoskelet Disord.* 2019 Oct 18;20(1):452. doi: 10.1186/s12891-019-2841-4. PMID: 31627723; PMCID: PMC6800493.
- [17] Nigam A, Satpute KH, Hall TM. Long term efficacy of mobilisation with movement on pain and functional status in patients with knee osteoarthritis: a randomised clinical trial. *Clin Rehabil.* 2021 Jan;35(1):80-89. doi: 10.1177/0269215520946932. Epub 2020 Jul 30. PMID: 32731750.
- [18] Heisig, J., Lindner, N., Kornder, N., Reichert, W., Becker, A., Haasenritter, J., Viniol, A., & van der Wardt, V. (2025). Adherence Support Strategies for Physical Activity Interventions in People With Chronic Musculoskeletal Pain—A Systematic Review and Meta-Analysis. *Journal of Physical Activity and Health*, 22(1), 4-52. Retrieved Sep 28, 2026, from <https://doi.org/10.1123/jpah.2024-0099>