

Correlation Between Reduction in Pain and Improvement in Function Multimodal Physiotherapy Approaches in Postmenopausal Women with Bilateral Knee Osteoarthritis

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Abstract:

➤ *Background:*

Knee Osteoarthritis is a common degenerative joint disorder among postmenopausal women, frequently associated with pain, reduced muscle strength, and functional limitations. Multimodal physiotherapy approaches are widely used to manage symptoms and improve functional outcomes. However, limited evidence exists regarding the correlation between pain reduction and functional improvement following such interventions.

➤ *Objective:*

To determine the correlation between reduction in pain and improvement in function following multimodal physiotherapy approaches in postmenopausal women with bilateral knee osteoarthritis.

➤ *Methods:*

Thirty postmenopausal women aged 40–60 years diagnosed with bilateral knee osteoarthritis (Kellgren–Lawrence Grade II–III) were allocated. Participants received Maitland Mobilisation combined with Multiple-Angle Isometrics, Interferential Current Therapy and Mini-Squats. The interventions were administered three sessions per week for four weeks. Pain intensity was assessed using the Numeric Pain Rating Scale (NPRS) while functional status was evaluated using the WOMAC (Western Ontario and McMaster Universities Osteoarthritis) Index. Pre-intervention and post-intervention scores were recorded. Correlation analysis was performed to determine the association between improvement in pain and functional outcomes using Pearson's correlation coefficient.

➤ *Results:*

Following the intervention, participants demonstrated significant reduction in pain and improvement in functional status. A positive correlation was observed between reduction in pain scores and improvement in WOMAC scores, indicating that participants who experienced greater pain relief also demonstrated greater functional improvement. The findings suggest that multimodal physiotherapy interventions effectively enhance clinical outcomes in postmenopausal women with bilateral knee osteoarthritis.

➤ *Conclusion:*

Multimodal physiotherapy approaches incorporating Maitland Mobilisation combined with Multiple-Angle Isometrics, Interferential Current Therapy and Mini-Squats were effective in reducing pain and improving function in postmenopausal women with bilateral knee osteoarthritis. Furthermore, a significant correlation existed between pain reduction and functional improvement, highlighting the interrelationship between these clinical outcomes during rehabilitation.

Keywords: Knee Osteoarthritis, Postmenopausal Women, NPRS, WOMAC, Maitland Mobilisation, Multiple-Angle Isometrics, Interferential Current Therapy, Mini-Squats.

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I. INTRODUCTION

Knee Osteoarthritis (KOA) is among the most prevalent degenerative musculoskeletal conditions and is commonly associated with pain, restricted mobility and diminished quality of life.[1] According to the Osteoarthritis Research Society International, osteoarthritis initially develops through molecular-level changes that gradually progress into structural and physiological alterations such as cartilage deterioration, bone remodeling, osteophyte development, joint inflammation and disruption of normal joint function.[2,3]

The reduction in estrogen levels after menopause is associated with a higher risk of developing osteoarthritis, particularly among postmenopausal women (PMW). Estrogen is believed to play a protective role by reducing inflammation, preserving chondrocyte function, and slowing degenerative changes within the articular cartilage, thereby delaying the progression of OA. [4,5]

In KOA, pain occurs due to stimulation of unmyelinated C fibers and small myelinated A-delta fibers within the knee joint and surrounding tissues. Inflammatory changes lower the nociceptive threshold, increasing pain sensitivity. Nociceptors are primarily located in the joint capsule, ligaments, synovium, subchondral bone, and peripheral menisci, making these structures major sources of pain in individuals with KOA.[6]

Regular physical activity plays an important role in maintaining and improving functional ability in individuals with KOA. Low activity levels may compromise functional performance and reduce independence in daily activities. [7]

Maitland Mobilisation is a manual therapy approach involving passive oscillatory joint movements applied through a graded system, enabling the physiotherapist to regulate the amplitude and rhythm of movement according to the patient's pain and joint stiffness.[8]

Multiple-angle Isometrics involve performing static muscle contractions at different joint angles to improve muscle activation throughout the available range of motion. This technique enhances muscle fiber recruitment by generating tension at multiple positions, leading to improved strength, neuromuscular control, and functional performance.[9]

Interferential Current Therapy (IFT) is a physical modality that produces sensory nerve stimulation with minimal discomfort while effectively penetrating deeper tissues. It is commonly used to reduce pain, improve circulation, and relieve muscle spasm in individuals with KOA by targeting deep-seated structures within the joint. [10,11]

Mini-squats is a closed kinetic chain exercise that involves coordinated movement of the hip, knee, and ankle joint. During the exercise, the quadriceps muscles generate an internal extension moment to oppose the external knee flexion moment produced by gravity and ground reaction forces.[12]

The aim of the study was to determine the correlation between reduction in pain and improvement in function following multimodal physiotherapy approaches in postmenopausal women with bilateral knee osteoarthritis.

II. METHODOLOGY

➤ *Study Design, Setting and Population*

This experimental study was conducted in the Outpatient Department (OPD) of the Department of Physiotherapy, Khalsa University, Amritsar. The study population consisted of postmenopausal women who were radiologically diagnosed with bilateral knee osteoarthritis of Kellgren–Lawrence Grade II–III.

➤ *Sampling*

The convenience sampling method was used to recruit participants. The sample size was calculated using G*Power (version 3.1) and the minimum sample size obtained was 30 participants.

➤ *Eligibility Criteria*

The inclusion criteria for recruitment were postmenopausal women aged 40–60 years, radiologically diagnosed bilateral knee osteoarthritis of Kellgren–Lawrence Grade II–III with radiographs obtained within six months prior to the commencement of the study, and persistent knee pain for a duration of at least 3 months.[2,13,14] The exclusion criteria were history of knee surgery or intra-articular injection within the previous 6 months, advanced knee osteoarthritis (Kellgren–Lawrence Grade IV), neurological disorders affecting gait or balance, systemic inflammatory diseases, acute trauma, fractures or ligamentous injuries of the lower limb, and concurrent participation in another physiotherapy or exercise trial.[13,15]

➤ *Outcome Measures*

The outcome measures included the Numeric Pain Rating Scale, a unidimensional tool used to assess pain severity. The NPRS consists of an 11-point numeric scale ranging from 0 to 10, where 0 indicates “no pain” and 10 represents “worst imaginable pain.” [16] Functional status was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), a standardized questionnaire widely used in individuals with knee osteoarthritis to evaluate pain, stiffness, and physical function. The WOMAC Index consists of 24 items divided into three subscales, including pain (5 items), stiffness (2 items), and physical function (17 items). Each item is scored using a five-point ordinal scale, and the questionnaire is

commonly used to assess activities of daily living, gait, functional mobility, general health, and quality of life in individuals with knee osteoarthritis.^[17]

➤ *Procedure*

Participants fulfilling the inclusion criteria were recruited after obtaining written informed consent. A baseline assessment was conducted prior to intervention. Patients received Maitland Mobilisation, Interferential Current Therapy, Multiple-angle Isometrics, and Mini-Squats. A total of 12 treatment sessions were administered three times per week over a period of four weeks.

Maitland Mobilisation was performed with the participant in supine lying, using Grade II and Grade III oscillatory glides for the tibiofemoral (anteroposterior, posteroanterior) and patellofemoral joint (caudal and cephalic). Mobilisation was applied at a rate of approximately two oscillations per second, with each glide administered for two minutes.

Interferential Current Therapy was delivered in supine lying with the knee supported in slight flexion. Four electrodes were placed around the knee joint in a quadripolar arrangement, and stimulation intensity was adjusted according to participant tolerance. The parameters included a 4 kHz carrier frequency, 100 Hz beat frequency, 150 Hz

sweep frequency, and 6:6 sweep mode for a duration of 20 minutes.

Multiple-Angle Isometrics were performed in sitting with the hip and knee flexed at 90°. Participants performed static knee extension contractions against resistance at 30°, 60°, and 90° of knee flexion, holding each contraction for 6 seconds. The exercise protocol consisted of 3 sets of 10 repetitions at each angle.

Mini-squats were performed in standing with feet shoulder-width apart while maintaining an upright trunk posture. Participants gradually flexed the knees and returned to the starting position in a controlled manner. The exercise was progressively advanced over four weeks by increasing the degree of knee flexion, number of repetitions, and resistance using 50%, 75%, and 100% of 10 RM weights.

➤ *Statistical Analysis*

Data were analyzed using SPSS software. Pre- and post-intervention comparisons were performed to determine the significance level. Paired t-test was used to compare the pre-intervention and post-intervention scores within the group. A p-value < 0.05 was considered statistically significant.

III. RESULTS

Table 1 Baseline Characteristics of Participants

Variable	Mean ± SD
Age (years)	50.93 ± 2.02
Height (m)	1.60 ± 0.03
Weight (kg)	70.01 ± 4.29
BMI (kg/m ²)	28.22 ± 1.99

Data are expressed as mean ± standard deviation (SD). Table 1 presents the descriptive analysis of baseline characteristics of the participants. The mean age of

participants was 50.93 ± 2.02, mean height was 1.60 ± 0.03 m, mean body weight was 70.01 ± 4.29 kg and mean BMI was 28.22 ± 1.99 kg/m².

Table 2 Analysis of Baseline and Post-Intervention Values of NPRS:

Variable	Pre Mean ± SD	Post Mean ± SD	t Value	p Value
NPRS	6.12 ± 0.70	2.32 ± 0.66	20.88	<0.001*

(Note: * Mark Indicates That p<0.05)

Table 2 demonstrates the analysis of baseline and post-intervention NPRS scores among participants. The mean pre-intervention NPRS score was 6.12 ± 0.70, which reduced to 2.32 ± 0.66 following intervention. Statistical analysis using

paired t-test revealed a significant reduction in pain intensity after treatment (t = 20.88, p < 0.001). These findings indicate that the intervention was effective in reducing pain among the participants.

Table 3 Analysis of Baseline and Post-Intervention Values of WOMAC:

Variable	Pre Mean ± SD	Post Mean ± SD	t Value	p Value
WOMAC	51.20 ± 8.65	22.67 ± 5.50	18.94	<0.001*

(Note: * Mark Indicates That p<0.05)

Table 3 demonstrates the analysis of baseline and post-intervention WOMAC scores among participants. The mean pre-intervention WOMAC score was 51.20 ± 8.65, which reduced to 22.67 ± 5.50 following intervention. Statistical analysis using paired t-test revealed a significant improvement

in functional status after treatment (t = 18.94, p < 0.001). These findings indicate that the intervention was effective in improving functional ability and reducing disability among the participants.

Table 4 Correlation Between Improvement in NPRS and WOMAC Score

Variables Compared	Correlation Coefficient (r)	p Value
NPRS vs WOMAC	0.432	0.017*

(Note: * Mark Indicates That $p < 0.05$)

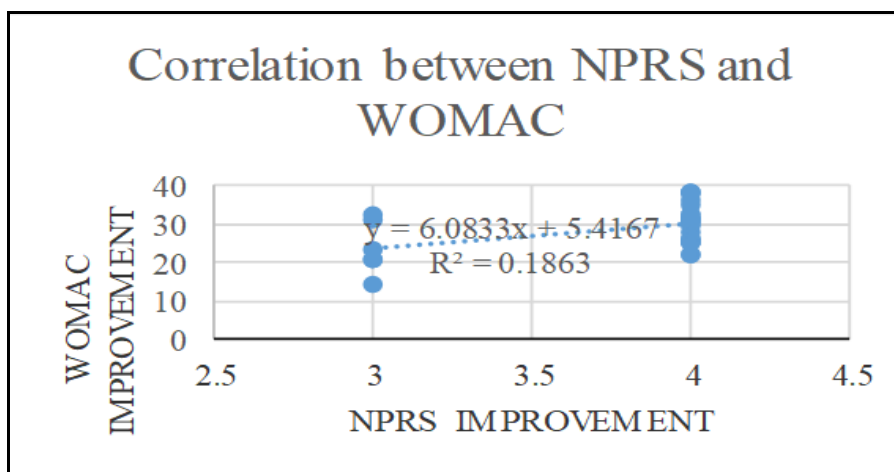


Fig 1 Scatter Plot Showing Correlation Between NPRS Improvement and WOMAC Improvement

Table 4 demonstrates that Pearson correlation analysis revealed a moderate positive statistically significant association between NPRS improvement and WOMAC improvement within Group B ($r = 0.432$, $p = 0.017$), indicating that greater reduction in pain was associated with greater improvement in functional outcome following intervention. Figure 1 demonstrates a moderate positive linear relationship between NPRS improvement and WOMAC improvement.

Statistically significant improvement was observed in both NPRS and WOMAC scores following intervention. A moderate positive statistically significant correlation was also found between improvement in pain and functional outcome.

IV. DISCUSSION

The present study was conducted to evaluate the effect of multimodal physiotherapy intervention on pain and functional outcome in postmenopausal women with bilateral knee osteoarthritis and to determine the correlation between improvement in pain and functional status following intervention. The findings of the study demonstrated statistically significant improvement in both NPRS and WOMAC scores after treatment, indicating the effectiveness of the intervention program. Additionally, Correlation analysis revealed a moderate positive statistically significant association between improvement in pain and functional outcome, indicating that greater reduction in pain was associated with greater improvement in functional ability following intervention.

Aysegul Atasoy-Zeybek and colleagues (2025) reported that postmenopausal hormonal alterations, especially decreased estrogen levels, adversely influence cartilage integrity, promote inflammatory processes and accelerate degenerative changes within the joint, thereby increasing the risk of knee osteoarthritis and related symptoms including

pain, limited mobility, muscle weakness and reduced functional independence.^[5]

Similarly, Y-P. Liu et al. (2018) stated that diminished ovarian activity during menopause results in lower estrogen and serum estradiol (E2) levels, while inflammatory mediators such as interleukin-1 (IL-1) further contribute to the progression of osteoarthritis.^[18]

Joel E. Bialosky et al. (2009) reported that oscillatory movement in Maitland Mobilisation activates joint mechanoreceptors, thereby modulating pain through spinal inhibitory pathways, leading to pain relief, tissue relaxation and improved joint mobility. The authors further explained that mobilisation facilitates synovial fluid movement, thereby enhancing cartilage nourishment and reducing mechanical stress on joint structures.^[19] Mutlu et al. (2018) found that the combination of joint mobilisation and exercise therapy significantly improved pain, range of motion and functional ability in individuals with knee osteoarthritis.^[20]

Similarly, Ata et al. reported significant reductions in pain and improvements in functional performance following Interferential Current Therapy among patients with knee osteoarthritis.^[21]

In addition, Parveen et al. (2024) demonstrated that Multiple-Angle Isometrics produced superior improvements in pain reduction and functional performance compared to conventional isometric exercises in individuals with knee osteoarthritis.^[22]

The findings of the present study are also in agreement with those of Desai et al. (2022), who reported that closed kinetic chain exercises, including Mini-Squats, resulted in greater enhancement of functional performance, dynamic balance and WOMAC scores in individuals with knee osteoarthritis. The authors suggested that these exercises improve proprioception, enhance joint stability and promote

better muscle coordination, thereby contributing to improved functional outcomes.^[23]

The present study had certain limitations that should be considered while interpreting the findings. The study was conducted on a relatively small sample size, which may limit the generalizability of the results to a larger population. The intervention duration and follow-up period were short; therefore, the long-term effectiveness of the multimodal physiotherapy program could not be determined. The study included only postmenopausal women with bilateral knee osteoarthritis of Kellgren–Lawrence Grade II–III, limiting the applicability of the findings to other populations and severity grades. In addition, the study mainly focused on pain and functional outcome measures, while variables such as muscle strength, balance, gait parameters and quality of life were not extensively evaluated.

Future studies are recommended with larger sample sizes, multicentric settings and long-term follow up. Comparative research involving different physiotherapy approaches may further identify the most effective intervention strategies for knee osteoarthritis. Future investigations may also incorporate additional outcome measures such as muscle strength, balance assessment, gait analysis and quality of life evaluation to obtain a more comprehensive understanding of functional recovery. Furthermore, similar studies can be conducted among different age groups, male participants and individuals with varying grades of knee osteoarthritis to broaden the clinical applicability of the findings.

V. CONCLUSION

The present study concluded that multimodal physiotherapy intervention comprising Maitland Mobilisation, Interferential Current Therapy, Multiple-Angle Isometrics and Mini-Squats was effective in reducing pain and improving functional outcome in postmenopausal women with bilateral knee osteoarthritis. Significant improvements were observed in both NPRS and WOMAC scores following intervention. Furthermore, a moderate positive statistically significant correlation was found between reduction in pain and improvement in functional status, indicating that greater pain relief was associated with better functional recovery. These findings support the clinical effectiveness of comprehensive physiotherapy rehabilitation in the management of knee osteoarthritis among postmenopausal women.

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