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Effects of an 8-Week Exercise and Manual Therapy Programme Versus Exercise Alone on Knee Pain and Joint Function in Postmenopausal Women With Knee Osteoarthritis

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Abstract

Background. The main cause of pain and functional impairment in postmenopausal women is knee osteoarthritis (KOA), which affects quality of life and reduces mobility. This research seeks to assess and contrast the impact of a combination of exercise and manual therapy against exercise on its own in relation to knee pain and functional outcomes in postmenopausal women with KOA. The objectives of this study are to assess the effect of exercise alone on knee pain and joint function, to determine the outcomes of exercise combined with manual therapy and compare the effectiveness of these two interventions in postmenopausal women with KOA. It is hypothesised that exercise combined with manual therapy would be more effective than exercise alone.

Aim. This study aims to evaluate and compare the effects of exercise and manual therapy versus exercise alone on knee pain and functional outcomes in postmenopausal women with KOA.

Methods. This randomised controlled trial recruited 40 participants divided into two equal groups. Both groups followed an eight-week physiotherapy programme, while one group also received manual therapy techniques. Pain (Visual Analogue Scale), joint function (WOMAC), range of motion (goniometry), and physical performance (Timed Up and Go Test) were assessed pre- and post-intervention.

Results. The findings indicated that both treatment methods notably alleviated pain and enhanced overall mobility. The combination of exercise and manual therapy resulted in more substantial positive changes in pain relief, range of motion, and functional mobility in comparison to exercise by itself. Nonetheless, there was no notable difference between the groups in joint function as assessed by the WOMAC.

Conclusions. Incorporating manual therapy into physiotherapy exercises can enhance the effectiveness of treatment for postmenopausal women suffering from KOA.

Keywords: knee osteoarthritis; postmenopausal women; exercise therapy; manual therapy; joint function

1. INTRODUCTION

Osteoarthritis (OA) is the most common joint disorder globally, characterised by progressive degeneration of multiple joint structures, including articular cartilage, subchondral bone, muscles, tendons, menisci, and synovium (Wolf et al., 2024). Clinically, OA typically presents with joint pain, stiffness, reduced range of motion (ROM), and weakness or atrophy of periarticular muscles (Santo et al., 2024).

In addition to advancing age, female sex—particularly postmenopausal women—is a significant risk factor for OA development and progression (Tschon et al., 2021). The incidence of OA peaks around the age of 50, coinciding with the onset of menopause. The increased prevalence in postmenopausal women is largely attributed to hormonal changes, notably declining estrogen levels and reduced bone mineral density (Dennison, 2022).

Among weight-bearing joints, the knee is the most commonly affected site. Women with knee osteoarthritis (KOA) generally experience greater functional decline and a more pronounced reduction in quality of life compared to men (Tschon et al., 2021). Physical activity is widely recognised as a cornerstone in OA management, offering benefits that extend beyond symptom relief to include improvements in overall health and functional capacity in postmenopausal women (Katz et al., 2021).

While numerous studies support the efficacy of exercise therapy in this population, there is limited research on the combined effects of exercise and manual therapy. Runge et al. (2022) demonstrated that integrating manual therapy with exercise led to superior short-term reductions in pain and enhancements in joint function among patients with hip or knee OA, compared to exercise therapy alone. Based on current evidence, it is hypothesised that a combined intervention of exercise therapy and manual therapy would significantly reduce pain and improve knee ROM, functional mobility, and physical performance in postmenopausal women with KOA, compared to exercise therapy alone. The aim of this study was to evaluate the effects of a combined intervention involving exercise and manual therapy, compared to exercise therapy alone, on knee pain, joint function, and overall physical performance in postmenopausal women with KOA.

2. METHODS

Study design and ethical considerations. This study was conducted as a randomised controlled trial (RCT) utilising a quantitative interventional approach with a two-time-point assessment framework: baseline (pre-intervention) and post-intervention evaluation, following the completion of an eight-week treatment protocol.

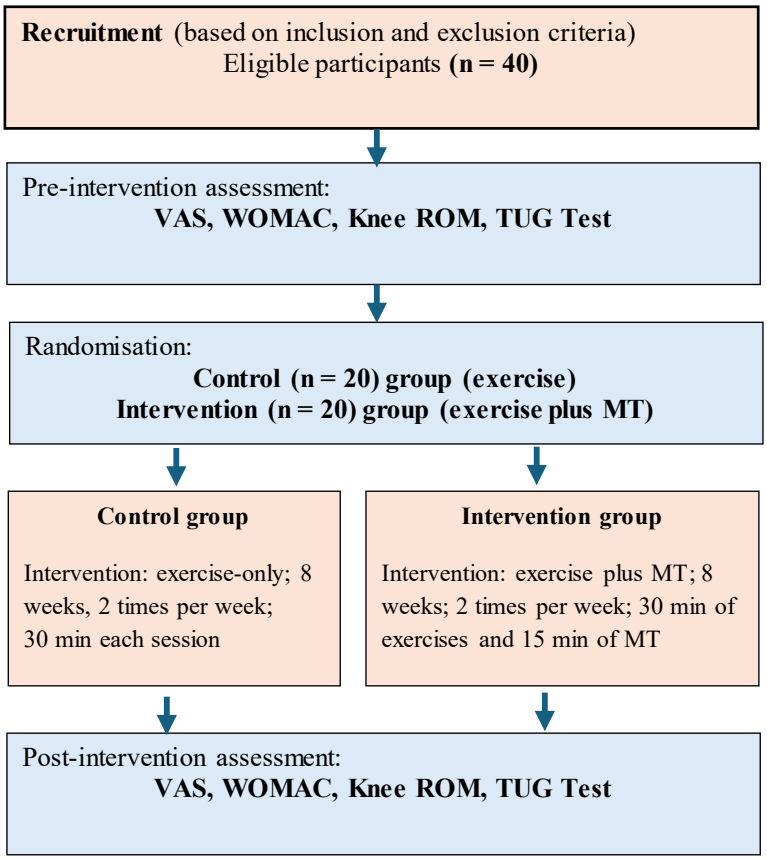
This study was approved by the Ethics Committee of the Lithuanian Sports University (approval number MNL-KIN (M)-2025-735, dated January 6, 2025). All assessments were carried out at the Physiotherapy and Rehabilitation Clinic in Tehran, Iran, adhering to standardised protocols to ensure measurement reliability and procedural consistency. Due to the nature of the intervention, complete blinding of the outcome assessors was not feasible. However, to minimise potential bias, standardised measurement procedures and data recording protocols were strictly followed. Outcome measurements were collected and recorded in an anonymised format to maintain confidentiality and reduce observer bias.

Study participants and randomisation. A sample of 40 postmenopausal women diagnosed with KOA was recruited for the study.

Participants were eligible if they met the following inclusion criteria: 1) aged between 45 and 65 years, 2) had a clinical diagnosis of KOA confirmed by radiographic and/or clinical criteria, 3) experienced knee pain for more than six months, 4) presented with grade II or III KOA according to the Kellgren–Lawrence radiographic grading scale, 5) had not received physiotherapy for KOA in the past three months, and 6) were physically capable of participating in an eight-week structured exercise therapy programme.

Exclusion criteria included: 1) a history of total knee replacement; 2) presence of systemic inflammatory conditions; 3) significant cardiovascular or neurological disorders, and 4) having received corticosteroid injections in the affected knee within the past three months.

Based on the inclusion and exclusion criteria, participants were randomly assigned to two groups: a control group and an intervention group (Figure 1).



Note: MT – manual therapy.

Figure 1. **Flow chart of the study**

Both groups participated in a structured exercise programme twice per week; however, the intervention group additionally received manual therapy techniques targeting the knee joints. The demographic characteristics of the participants are presented in Table 1. There were no statistically significant differences between the groups in terms of age, height, weight, BMI, osteoarthritis (OA) severity based on Kellgren–Lawrence grade, or OA duration, indicating that the groups were comparable at the start of the study.

Table 1. **Baseline characteristics of study participants**

Characteristic	Control group (n = 20)	Intervention group (n = 20)	P between groups
Age (year ± SD)	57.30 ± 4.62	57.55 ± 5.15	0.566
Height (m ± SD)	1.62 ± 0.06	1.62 ± 0.07	0.950
Weight (kg ± SD)	73.88 ± 10.18	76.16 ± 9.31	1.000
BMI (kg/m^2 ± SD)	28 ± 3.04	28.70 ± 2.74	0.993
OA severity (K–L grade)	2.5 ± 0.51	2.6 ± 0.50	0.527
OA duration (months ± SD)	19 ± 8.25	19.15 ± 9.18	0.995

Interventions

Exercise therapy (for both groups). A structured physiotherapy programme was designed to improve strength (Genç & Atılgan, 2024; Bennell et al., 2020), joint mobility (Eymir et al., 2020), proprioception, and functional performance (Bennell et al., 2020) in postmenopausal women with KOA.

Each session included around 8 to 10 exercises designed to improve lower limb strength, flexibility, and balance. The exercises were varied and performed in different positions, such as sitting (e.g., leg extensions), supine (e.g., bridges), standing (e.g., mini squats, step-ups), and prone (e.g., hamstring curls). Each exercise was performed for three sets of 10–15 repetitions, with modifications based on participant tolerance and progress.

Every physiotherapy visit started with a five-minute warm-up and ended with a cool-down phase, and the intensity of exercises gradually modified based on personal tolerance.

Manual therapy (for intervention group). In addition to exercise, intervention group received 15 minutes of manual therapy after each PT session. The joint mobilisation part involved applying a steady, controlled force to the patellofemoral joint while participants did active knee flexion and extension from 90° to the maximum available extension, which was designed for pain reduction and joint mobility. The second part of the intervention included myofascial mobilisation that was focused on tense myofascial areas in the anterior thigh (Nath, 2015; Kandada & Heggannavar, 2015).

Both eight-week interventions were well tolerated by participants, with no adverse effects reported throughout the study period.

Outcome measures

Visual Analogue Scale (VAS) was used for pain assessment (Zhang et al., 2023). Individuals scored their current knee pain on a scale from 0 (no pain) to 10 (extreme pain).

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used to evaluate joint function. The Persian-translated and validated version of the WOMAC (VAS 100 mm version) was used, consisting of three subscales: pain (5 items), stiffness (2 items), and physical function (17 items). Scores ranged from 0 to 2 400, with higher scores indicating more severe symptoms (Eftekhar-Sadat et al., 2015).

Knee ROM. Knee flexion ROM was measured using a 360° goniometer while the participants were in the supine position, with hips in a neutral position. Participants were asked to actively flex the knee as far as comfortably possible while the examiner recorded the angle.

Timed Up and Go (TUG) *Test* was employed to assess the physical performance of participants. This test measured the time taken for an individual to stand from a chair, walk three metres, turn around, walk back, and sit down. A faster time indicates better mobility condition and lower fall risks (Roochi et al., 2021).

Statistical analysis

Statistical analysis was conducted using IBM SPSS Statistics software (Version 26.0, IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed through skewness (acceptable range ± 1.5) and kurtosis (acceptable range ± 2). All variables met the criteria for normal distribution. Descriptive statistics were presented as mean ± standard deviation (SD) for continuous variables and as frequencies with percentages for categorical variables. Baseline differences between the control and intervention groups were evaluated using Independent Sample T-Test for continuous variables and Chi-Square Test for categorical variables. To assess the effect of the intervention over time, a repeated measures Analysis of Variance (ANOVA) was employed, with Dunnett's Post Hoc Test applied when appropriate. In addition, Analysis Of Covariance (ANCOVA) was conducted to adjust for potential confounding variables such as age, body mass index (BMI), and osteoarthritis severity (Kellgren–Lawrence grade 2 or 3), ensuring a more accurate evaluation of the intervention's impact. Within-group changes

from baseline to post-intervention (week eight) were analysed using Paired Sample T-Test for each group separately. Outcome measures included pain intensity (VAS), joint function (WOMAC Function Subscale), knee ROM (flexion), and physical performance (TUG Test). All analyses were conducted using a per-protocol approach, and statistical significance was set at a p-value < 0.05.

3. RESULTS

Table 2 presents the within- and between-group comparisons for pain (VAS), joint function (WOMAC Function Subscale), knee ROM, and physical performance (TUG Test) before and after the eight-week intervention. Both the control and intervention groups showed statistically significant improvements within groups across all measured outcomes ($p < 0.001$). However, between-group comparisons revealed that the intervention group experienced significantly greater improvements in pain reduction (VAS) ($F = 41.53$, $p < 0.001$, $\eta^2 = 0.52$), knee flexion ROM ($F = 56.66$, $p < 0.001$, $\eta^2 = 0.61$), and physical performance (TUG Test) ($F = 13.27$, $p = 0.001$, $\eta^2 = 0.46$), indicating large effect sizes in favour of the combined intervention. While both groups improved significantly in WOMAC Function Subscale scores, the between-group difference did not reach statistical significance ($p = 0.234$), with a small effect size ($\eta^2 = 0.03$). These findings suggest that the addition of manual therapy to exercise therapy may have a more pronounced effect on pain, mobility, and functional performance in postmenopausal women with KOA.

Table 2. **Within and between group comparisons for VAS (pain score), WOMAC Function Subscale (joint mobility), ROM, and TUG Test (physical performance)**

Outcomes	Group	Pre-test Mean ± SD	Post-test Mean ± SD	p-value within group	Effect size (partial eta squared)	p-value between group
VAS (pain score)	C	7.29 ± 1.01	4.99 ± 1.20	$p < 0.001$	$\eta^2 = 0.52$	0.000
	I	7.59 ± 1.23	4.07 ± 1.21	$p < 0.001$	$F = 41.53$	
WOMAC total	C	61.30 ± 11.57	43.92 ± 12.68	$p < 0.001$	$\eta^2 = 0.03$	0.234
	I	62.55 ± 10.15	39.63 ± 9.52	$p < 0.001$	$F = 1.46$	
ROM (degree)	C	106.75 ± 6.83	115.58 ± 6.72	$p < 0.001$	$\eta^2 = 0.61$	0.000
	I	105.45 ±7.42	118.85 ± 8.34	$p < 0.001$	$F = 56.66$	
TUG Test (seconds)	C	14.99 ± 2.57	12.26 ± 2.79	$p < 0.001$	$\eta^2 = 0.46$	0.001
	I	14.18 ± 2.38	10.34 ± 2.45	$p < 0.001$	$F = 13.27$	

Note: C – control group; I – intervention group.

Figure 2 illustrates scatter plots depicting the linear relationships between pre-test and post-test scores for the four primary outcome measures: VAS (pain intensity), WOMAC (joint function), ROM (knee flexion), and TUG Test (physical performance). Each plot demonstrates a clear linear trend, indicating consistent changes from baseline to post-intervention across participants. The downward slopes in VAS and TUG Test plots reflect reductions in pain and improved functional mobility, respectively, while the upward trends in WOMAC and ROM suggest enhanced joint function and increased ROM. These visual patterns support the quantitative findings and reinforce the effectiveness of the intervention strategies applied in this study.

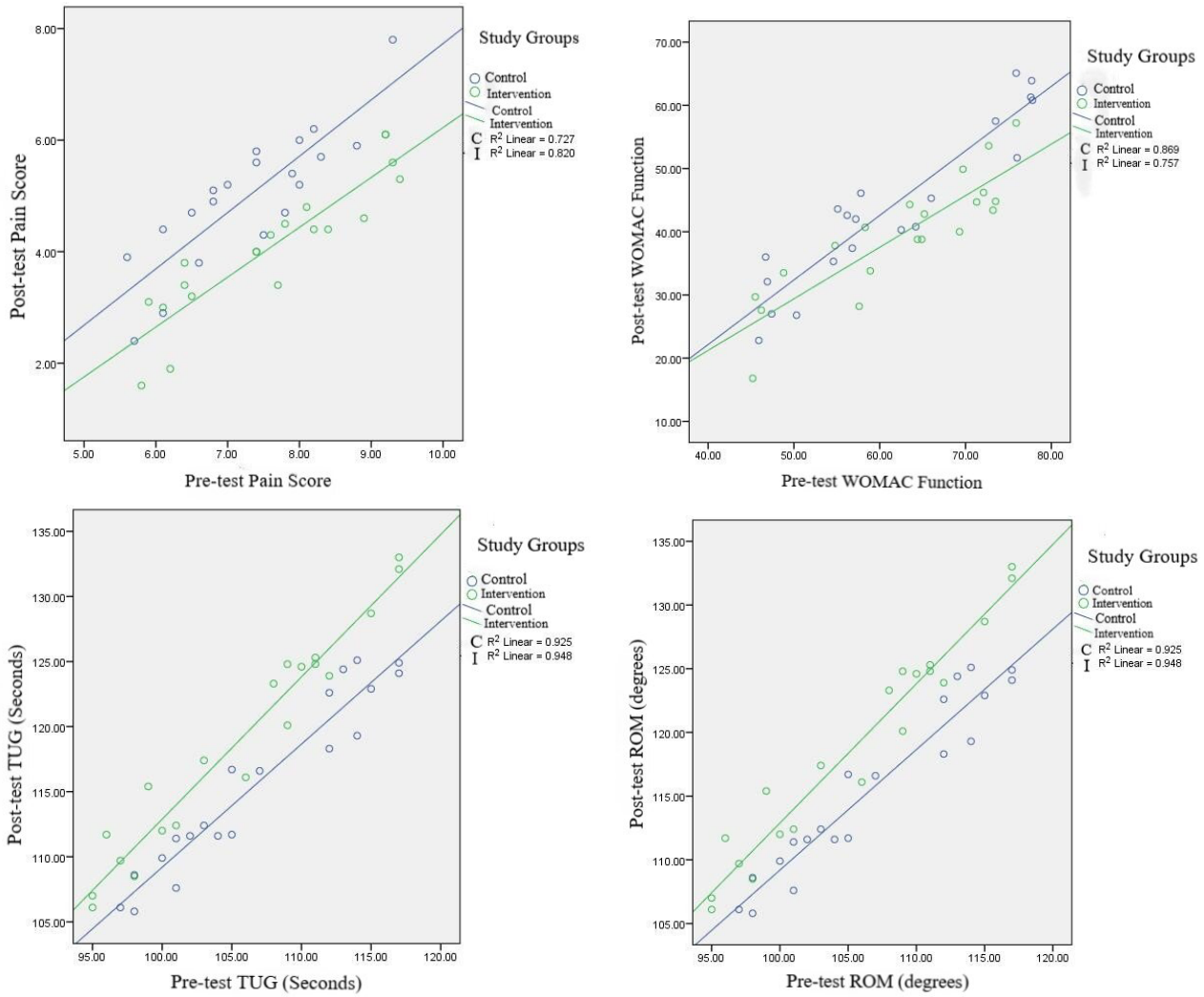


Figure 2. **Scatter plots showing the linear relationship between pre- and post-test scores for VAS, WOMAC, ROM, and TUG Test**

4. DISCUSSION

This study examined the effects of a combined intervention of exercise and manual therapy on pain, joint function, ROM, and mobility in postmenopausal women with KOA. The findings demonstrate that incorporating manual therapy into a structured exercise regimen leads to greater improvements in most outcome measures compared to exercise alone. These results suggest that manual therapy, as an adjunct to exercise therapy, can significantly enhance the management of KOA-related clinical symptoms in this population.

Both the control and intervention groups experienced statistically significant reductions in pain levels, as assessed by the Visual Analogue Scale (VAS). However, the intervention group exhibited a significantly greater reduction in pain scores than the control group, highlighting the enhanced analgesic effect of the combined approach. These results are consistent with the findings of Santo et al. (2024), who reported that manual therapy effectively reduces pain in patients with KOA.

Regarding joint function, as measured by the WOMAC, both groups demonstrated significant within-group improvements. Although the intervention group showed a greater numerical improvement, the between-group comparison did not reach statistical significance. The relatively small effect size sug-

gests that the impact of manual therapy on joint function, while present, may require a longer intervention duration to yield more robust between-group differences. These observations are aligned with the findings of Wolf (2024), who reported improvements in joint function with exercise programmes but no significant differences between groups in WOMAC pain or stiffness subdomains.

ROM improved significantly in both groups, with a greater increase observed in the intervention group. This suggests that manual therapy contributed to enhanced joint flexibility and reduced mechanical restrictions, consistent with the findings of Tsokanos et al. (2021), who highlighted the role of manual therapy in restoring joint mobility in KOA patients.

Functional mobility, assessed using the TUG Test, also improved significantly in both groups, with the intervention group showing superior gains. The between-group difference post-intervention was statistically significant, supporting the hypothesis that manual therapy combined with exercise more effectively enhances physical performance and lower limb joint function. These results are in agreement with Kılıç et al. (2020), who demonstrated that combined interventions improve TUG Test scores more than exercise alone.

Collectively, the findings of this study align with previous literature indicating that manual therapy can complement exercise therapy in the conservative management of KOA. As reported by Santo et al. (2024) and Wolf et al. (2024), while exercise alone improves physical function, its effects on pain and stiffness may be augmented by the addition of manual therapy.

KOA is a progressive degenerative condition characterised by cartilage breakdown, subchondral bone remodelling, and synovial inflammation (Sánchez-Romero et al., 2021). Contributing factors such as mechanical loading, hormonal changes, metabolic alterations, and aging accelerate disease progression. While pharmacological and surgical treatments are available, exercise-based physiotherapy is widely recognised as a key non-pharmacological approach. It helps reduce inflammation, improve joint stability, and delay cartilage degeneration. The results of the present study support this view, showing improvements in pain, joint function, and ROM following the intervention, likely due to enhanced neuromuscular activation and mechanical load redistribution.

Additionally, Tsokanos et al. (2021) reported that manual therapy can significantly reduce pain and improve joint function, though they emphasised the need for further research to compare its efficacy with other modalities and to assess long-term outcomes. Kılıç et al. (2020) also observed that combining aerobic exercise with physiotherapy produced superior improvements in VAS scores, functional outcomes, and WOMAC scores.

Despite the consistent improvements observed, some studies have reported mixed results. For example, although a study published in *Osteoarthritis and Cartilage* journal found that manual therapy combined with exercise improved clinical symptoms, the changes in WOMAC scores were not significantly different from those achieved through usual care. Conversely, a randomised controlled trial by Deyle et al. (2005) showed that clinic-based physical therapy incorporating manual therapy and exercise nearly doubled the improvement in WOMAC scores compared to a home exercise programme. Such discrepancies may reflect differences in study design, sample characteristics, intervention duration, and adherence rates.

A systematic review and meta-analysis by Runge et al. (2022) concluded that manual therapy combined with exercise therapy provides short-term benefits but offers no significant long-term advantage in pain or functional outcomes. These divergent findings underscore the need for standardised intervention protocols and long-term studies to determine the sustained efficacy of combined therapies.

In clinical practice, manual therapy is frequently used alongside exercise to enhance treatment outcomes in KOA, despite current guidelines offering only limited recommendations. Its use is often justified by its ability to improve ROM, reduce stiffness, and alleviate pain.

In summary, the current study indicates that a combined intervention of exercise and manual therapy provides superior outcomes in pain relief, physical function, ROM, and mobility in postmenopausal women with KOA compared to exercise therapy alone. This approach represents a promising non-pharmacological strategy for managing KOA symptoms.

However, the study has limitations, including a relatively short intervention duration and absence of long-term follow-up, which may limit the generalisability of the findings. Future research should focus on exploring the sustained effects of combined interventions over extended periods and across more diverse patient populations.

5. CONCLUSIONS AND PERSPECTIVES

Patients who received exercise therapy demonstrated statistically significant improvements in knee pain, physical function, ROM, and mobility from baseline to post-intervention. These findings confirm the effectiveness of structured exercise in reducing symptoms and enhancing joint function in postmenopausal women with KOA. Patients who received the combined intervention of exercise and manual therapy showed even greater within-group improvements across all outcome measures. This suggests that incorporating manual therapy may enhance the therapeutic effects of exercise, particularly in alleviating pain and improving mobility and joint flexibility. However, no significant between-group difference was observed in WOMAC scores, indicating that while manual therapy may offer added benefits for specific physical outcomes, its effect on self-reported functional status may require longer intervention duration or larger sample sizes to be clearly demonstrated.

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Aštuonių savaičių trukmės mankštos ir manualinės terapijos programos poveikis moterų po menopauzės, sergančių kelio osteoartritu, kelio skausmui ir sąnario funkcijai, palyginti su tik mankštos poveikiu

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Santrauka

Tyrimo pagrindimas. Kelio osteoartritas (KOA) – pagrindinė skausmo ir funkcinių sutrikimų priežastis moterims po menopauzės, ribojanti judrumą ir mažinanti gyvenimo kokybę. Šiuo tyrimu siekta įvertinti ir palyginti kombinuotos mankštos ir manualinės terapijos programos poveikį su tik mankštos poveikiu moterų po menopauzės, sergančių KOA, kelio skausmui ir sąnario funkcijai. Tyrimo uždaviniai: įvertinti mankštos poveikį kelio skausmui ir sąnario funkcijai, nustatyti mankštos ir manualinės terapijos programos rezultatus ir palyginti šių dviejų intervencijų veiksmingumą moterų po menopauzės, sergančių KOA, grupėse. Hipotezė – mankštos ir manualinės terapijos derinimas bus veiksmingesnis nei tik mankšta.

Tikslas. Įvertinti ir palyginti aštuonių savaičių trukmės mankštos ir manualinės terapijos programos poveikį su tik mankštos poveikiu moterų po menopauzės, sergančių KOA, kelio skausmui ir sąnario funkcijai.

Metodai. Šiame atsitiktinių imčių kontroliuojamame tyrime dalyvavo 40 dalyvių, padalintų į dvi lygias grupes. Abi grupės turėjo aštuonių savaičių trukmės fizioterapijos mankštinimosi pratybas, bet vienai grupei papildomai taikyta manualinė terapija. Prieš ir po intervencijos buvo vertinami skausmas (vizualinė analoginė skalė), sąnario funkcija (WOMAC indeksas), judesių amplitudė (goniometrija) ir fizinis pajėgumas („Stotis ir eiti“ testas).

Rezultatai. Rezultatai parodė, kad abi intervencijos reikšmingai sumažino skausmą ir pagerino judrumą. Mankšta kartu su manualine terapija lėmė didesnį skausmo sumažėjimą, judesių amplitudės ir sąnario funkcijos pagerėjimą, palyginti su tik mankšta. Tačiau reikšmingų skirtumų tarp grupių vertinant sąnario funkciją (pagal WOMAC indeksą) nenustatyta.

Išvados. Manualinės terapijos derinimas su fizioterapijos mankštinimosi pratybomis gali padidinti gydymo veiksmingumą moterims po menopauzės, sergančioms KOA.

Reikšminiai žodžiai: kelio osteoartritas; po menopauzės esančios moterys; mankštos terapija; manualinė terapija; sąnario funkcija

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