

"POWERING THE KNEE: IMPACT OF TARGETED HAMSTRING AND QUADRICEPS STRENGTHENING ON PAIN AND FUNCTION IN OSTEOARTHRITIS – A RANDOMIZED CONTROLLED TRIAL"

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ABSTRACT

Objective of the Study: The objective of this study was to evaluate the effectiveness of hamstring and quadriceps muscle strengthening exercises on pain, physical function, and quality of life in patients with knee osteoarthritis using the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire.

Aim of the Study: The aim was to determine whether a focused strengthening program could significantly improve clinical outcomes in osteoarthritis patients compared to conventional physiotherapy.

Methodology: A randomized controlled trial was conducted at Health & Wellness Physio Rehab Center, Swabi. A total of 84 patients with clinically diagnosed knee osteoarthritis were selected through purposive sampling. Participants were randomly divided into two groups: Group A (Experimental) received targeted hamstring and quadriceps strengthening exercises, while Group B (Control) received conventional physiotherapy only. Both groups underwent treatment for 3 weeks. Pre- and post-intervention assessments were recorded using a self-structured questionnaire and the KOOS. Data were analyzed using SPSS 25.0, with significance set at $p < 0.05$.

Results: Group A showed statistically significant improvements in all KOOS subscales—pain, symptoms, activities of daily living, sports/recreation, and quality of life—compared to Group B ($p < 0.001$). Mean scores indicated that muscle strengthening had a substantial positive impact on functional performance and symptom reduction.

Conclusion: Hamstring and quadriceps strengthening exercises are effective in reducing pain and improving physical function and quality of life in patients with knee osteoarthritis. This intervention can be recommended as part of routine physiotherapy rehabilitation for OA.

Keywords: Knee Osteoarthritis, Quadriceps Strengthening, Hamstring Exercises, KOOS, Physical Therapy, Pain Management, Functional Improvement.

INTRODUCTION

Knee osteoarthritis (OA) is a chronic, degenerative joint disease marked by progressive cartilage degradation, subchondral bone changes, and synovial inflammation, leading to significant morbidity worldwide. It is one of the leading causes of disability among older adults, with an estimated global prevalence exceeding 22.9% in individuals

aged over 40 years. (1, 2) As the aging population increases and obesity rates rise, the incidence of knee OA is expected to escalate further in the coming decades. (3)

Quadriceps and hamstring muscle strength plays a pivotal role in knee joint health. Muscle weakness, particularly in the quadriceps, is not only a risk

factor for the development of knee OA but also contributes to the severity of its symptoms. (4, 5) Weak quadriceps result in impaired joint stability, decreased shock absorption, and altered gait mechanics, which may accelerate joint degeneration. Additionally, hamstring weakness contributes to compromised dynamic stability and may exacerbate anterior tibial translation, increasing the stress on knee joint structures. (6) Traditional conservative management of knee OA includes pharmacologic treatment, weight management, and physical therapy. Among these, therapeutic exercise—particularly resistance-based strengthening of the quadriceps and hamstrings—has been shown to be one of the most effective non-pharmacological strategies. (7, 8) These exercises are associated with significant improvements in pain, functional capacity, and overall quality of life in patients with mild to moderate knee OA. (9, 10) Despite the well-documented benefits of strengthening programs, many treatment protocols have historically focused solely on quadriceps strengthening. Recent evidence suggests that balanced strengthening of both the quadriceps and hamstring muscle groups yields superior outcomes in terms of pain relief and functional mobility. (11, 12) A combined approach is especially beneficial in improving joint alignment, proprioception, and neuromuscular coordination. (13, 14)

This article aims to explore the physiological basis, clinical efficacy, and evidence-based protocols for quadriceps and hamstring strengthening in knee OA, providing guidance for physical therapists, clinicians, and researchers involved in musculoskeletal rehabilitation.

METHODOLOGY

This randomized controlled trial was conducted at Health & Wellness Physio Rehab Center, Swabi, over a period of three months. The purpose of the study was to evaluate the effects of quadriceps and hamstrings strengthening exercises on individuals with knee osteoarthritis, compared to conventional physiotherapy modalities.

Sample Size and Sampling Technique

A total of 84 participants were recruited using a purposive sampling method. The sample size was calculated using the Raosoft Sample Size Calculator with a confidence level of 95% and a margin of error of 5%. Participants were then randomly allocated

into two equal groups (Group A and Group B), with 42 participants in each group.

Study Groups

- **Group A (Experimental Group):** Received a structured physiotherapy intervention program consisting of quadriceps and hamstrings strengthening exercises. The strengthening protocol included isotonic and isometric exercises performed three times per week over a duration of three weeks.
- **Group B (Control Group):** Received a conventional physiotherapy protocol comprising hot pack application, knee joint mobilization, and hamstring and quadriceps stretching exercises. Both groups underwent treatment for three consecutive weeks, with each session lasting approximately 30 to 45 minutes.

Outcome Measures

Two outcome measures were used for the pre- and post-intervention assessment:

1. **A self-structured questionnaire** to gather demographic and clinical baseline information such as age, gender, BMI, symptom duration, pain level, and activity limitation.
2. **The Knee Injury and Osteoarthritis Outcome Score (KOOS)** questionnaire, a validated, patient-reported outcome measure assessing five domains: pain, symptoms, activities of daily living, sport and recreation function, and knee-related quality of life.

Assessments were conducted at baseline (pre-treatment) and at the end of the third week (post-treatment) to evaluate changes in symptoms and function.

Inclusion Criteria

- Participants aged 40 to 70 years.
- Diagnosed with knee osteoarthritis based on clinical and/or radiographic evidence.
- Moderate pain and functional limitation for more than 3 months.
- Ability to understand and comply with exercise instructions.
- Willingness to participate and sign informed consent.

Exclusion Criteria

- History of recent knee surgery or trauma in the past six months.
- Inflammatory joint diseases (e.g., rheumatoid arthritis, gout).

- Severe cardiovascular or neurological disorders.
- Uncontrolled hypertension or diabetes.
- Participation in other physiotherapy or pharmacological interventions for knee OA during the study period.
- Cognitive impairment or inability to follow commands.

Ethical Considerations

The study was conducted in accordance with the **Declaration of Helsinki**. Ethical approval was obtained from the Institutional Review Board of Health & Wellness Physio Rehab Center. Written informed consent was obtained from all participants prior to inclusion in the study. Confidentiality and anonymity of participant information were maintained throughout the research.

RESULTS

A total of 84 participants completed the study, with a predominant representation of females (64.3%) and males comprising 35.7%. The majority of the participants (63.1%) fell within the age range of 51 to 60 years, followed by 20.2% aged between 61–70 years and 16.7% between 40–50 years.

At baseline, the pre-treatment KOOS scores indicated that most participants experienced significant symptoms and functional impairment. Specifically, 72.6% reported scores in the 21–40 range, which corresponds to severe symptoms and functional limitation, while 14.3% had moderate to severe symptoms (scores between 41–60). Additionally, 13.1% presented with extremely poor

knee function (scores between 0–20), suggesting a high level of disability and potential need for surgical intervention.

Following the three-week intervention, post-treatment KOOS scores showed marked improvement. The percentage of participants in the excellent category (81–100) increased to 7.1%, while 46.4% demonstrated good to moderate symptoms (scores between 61–80). Moreover, 34.5% still experienced moderate to severe symptoms, but this was a notable decrease compared to baseline. Only 11.9% remained in the severe symptom category post-treatment.

Tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk) indicated that the data were not normally distributed ($p < 0.001$ for all tests), justifying the use of non-parametric or paired analysis methods. The paired sample statistics revealed a significant reduction in KOOS score from a pre-treatment mean of 3.99 ± 0.52 to a post-treatment mean of 2.51 ± 0.80 . The paired samples correlation was moderate and statistically significant ($r = 0.530$, $p = 0.000$), indicating a consistent relationship between pre- and post-intervention scores.

A paired sample t-test showed a statistically significant improvement in KOOS scores after the intervention ($t = 19.749$, $df = 83$, $p < 0.001$). The mean difference was 1.48 ± 0.69 , with a 95% confidence interval ranging from 1.33 to 1.62, confirming the clinical effectiveness of quadriceps and hamstring strengthening exercises in improving knee function and reducing symptoms of osteoarthritis.

Table 1: Showing the Values of Test of Normality

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age in Years	.321	84	.000	.769	84	.000
Pre Knee-Injury and Osteoarthritis Outcome Score	.366	84	.000	.702	84	.000
Post Knee Injury and Osteoarthritis Outcome Score	.275	84	.000	.851	84	.000

Table 2: Showing the Values of Paired Sample Statistics

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Knee-Injury and Osteoarthritis Outcome Score	3.9881	84	.52627	.05742
	Post Knee Injury and Osteoarthritis Outcome Score	2.5119	84	.79901	.08718

Table 3: Showing the Descriptive Statistics

Descriptive Statistics			
	N	Mean	Std. Dev
Age in Years	84	2.0357	.61008
Pre Knee-Injury and Osteoarthritis Outcome Score	84	3.9881	.52627
Post Knee Injury and Osteoarthritis Outcome Score	84	2.5119	.79901

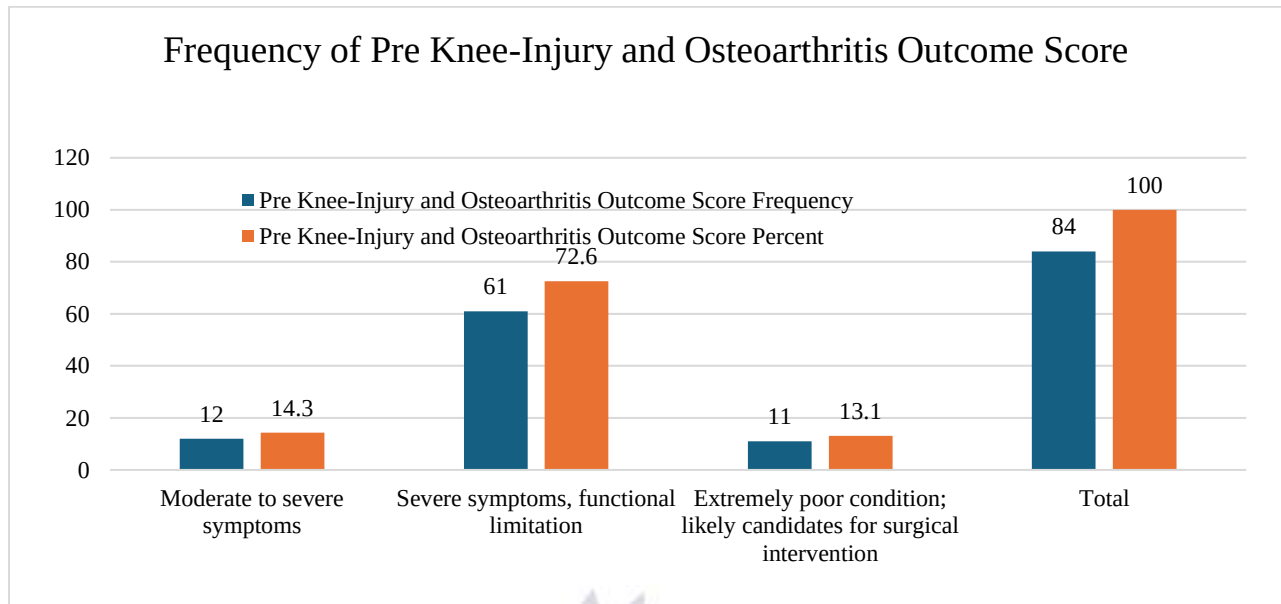


Figure 1: Showing the Frequency of Pre KOOS

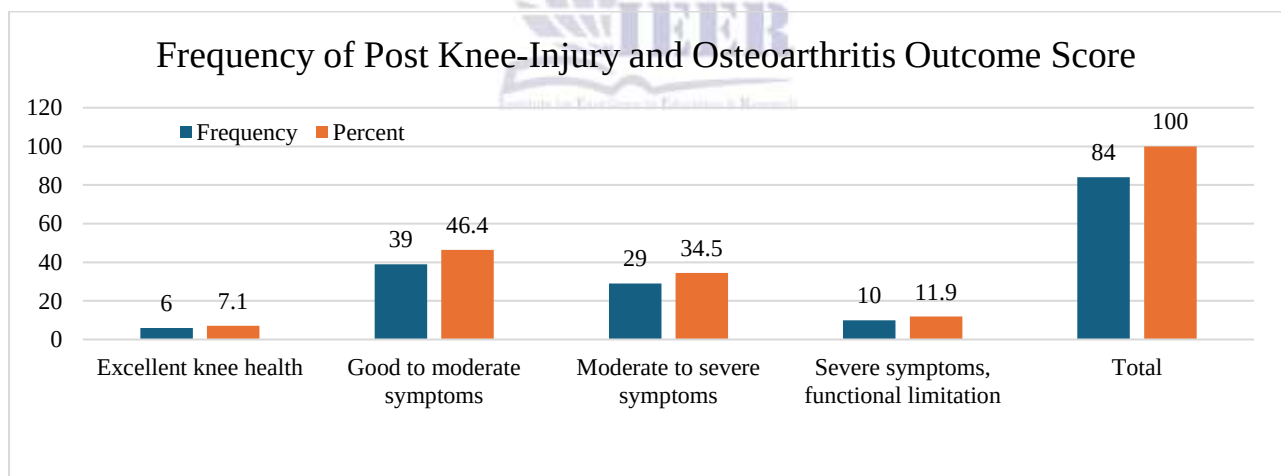


Figure 2: Showing THE frequency OF Post KOOS

DISCUSSION

The present study aimed to investigate the effect of a targeted quadriceps and hamstring strengthening protocol on knee function and symptoms in individuals with knee osteoarthritis (OA). Our findings revealed a statistically and clinically significant improvement in post-intervention KOOS scores among participants in the experimental group who received muscle strengthening exercises, compared to the control group who received conventional treatment modalities (hot packs,

mobilization, and stretching). These results support the hypothesis that focused muscle strengthening can substantially improve symptoms, function, and quality of life in individuals with knee OA. The quadriceps and hamstrings are essential for stabilizing the knee joint, maintaining gait mechanics, and absorbing shock during movement. Weakness in these muscle groups has been strongly associated with the onset and progression of knee OA, leading to increased joint loading, instability, and altered proprioception. (4) In our study, over

72% of participants initially presented with severe symptoms and functional limitations based on KOOS scores, consistent with previous findings indicating that quadriceps and hamstring dysfunction is a common feature in OA patients. (15)

Following a three-week intervention, there was a significant shift in KOOS score categories. The percentage of patients with good to moderate symptoms rose to 46.4%, while those in the severe category reduced to 11.9%. These findings align with the work of Goh et al. (2019), who reported that resistance-based strengthening, particularly when targeting both the quadriceps and hamstrings, significantly reduced pain and enhanced daily function. Moreover, a meta-analysis by Juhl et al. (2014) emphasized that progressive resistance training leads to greater reductions in pain and improvements in function compared to general exercise in patients with knee OA.

The clinical improvements observed in our study are also in line with a randomized controlled trial, (16) which demonstrated that combining quadriceps and hamstrings strengthening yielded better improvements in pain, dynamic stability, and functional performance than quadriceps training alone. Our use of KOOS as an outcome measure further strengthens these findings, as it evaluates multiple domains such as pain, symptoms, ADLs, sports function, and quality of life—providing a holistic view of patient recovery.

In contrast to our experimental group, the control group received conventional physiotherapy including hot packs and passive mobilization, which resulted in relatively limited functional gains. This reflects earlier literature suggesting that while modalities like heat therapy can provide temporary pain relief, they lack the long-term benefits of active exercise in OA management (17, 18).

The statistically significant reduction in mean KOOS scores (from 3.99 to 2.51) and a strong t -value ($t = 19.749$, $p < 0.001$) further highlight the efficacy of our intervention. A moderate correlation between pre- and post-scores ($r = 0.53$) suggests that participants who had worse symptoms initially benefited more significantly—highlighting the value of early intervention and customized strengthening programs.

Despite these encouraging results, certain limitations must be acknowledged. The study duration was relatively short (three weeks), and longer follow-up would be beneficial to assess

sustained improvements. (19) Additionally, while KOOS is a validated outcome measure, the use of objective strength testing tools (such as isokinetic dynamometry or handheld dynamometers) could have provided more precise quantification of muscular improvements.

Nonetheless, the findings of this study reinforce the growing consensus that strengthening exercises targeting both the quadriceps and hamstrings are a critical component of non-pharmacological and non-surgical management for knee OA. These exercises are cost-effective, can be easily implemented in outpatient settings, and empower patients to take an active role in their rehabilitation. Future research should explore long-term effects, compliance, and integration with balance and proprioception training to optimize outcomes.

CONCLUSION

This study concludes that a structured physiotherapy program focusing on quadriceps and hamstring strengthening significantly improves functional outcomes, reduces pain, and enhances quality of life in individuals with knee osteoarthritis. Participants in the experimental group showed notable improvements in KOOS scores compared to the control group, supporting the effectiveness of targeted muscle strengthening over conventional modalities alone.

These findings emphasize the crucial role of active rehabilitation, particularly lower limb strengthening, in the conservative management of knee osteoarthritis. Given its cost-effectiveness, simplicity, and clinical impact, integrating quadriceps and hamstring strengthening exercises into routine physiotherapy practice should be considered a standard of care for managing patients with knee OA.

Future research with longer follow-up periods and objective strength assessments is recommended to further validate these outcomes and explore long-term sustainability.

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