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Original Article

Comparative Effects of High and Low Intensity Progress Resisted Exercises on Pain, Range of Motion and Functional Disability in Knee Osteoarthritis Patients with Sarcopenia: A Randomized Controlled Trial

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ABSTRACT

Background: Osteoarthritis is the most common kind of arthritis, affecting millions of people. It develops because of the slow loss of the protective cartilage that cushions the ends of the bones over time. Although osteoarthritis may affect any joint, it is most often connected with joints in the hands, knees, hips, and spine.

Objective: To compare the effects of high and low intensity progressive resisted exercises on pain, range of motion and functional disability in knee osteoarthritis patients with sarcopenia.

Methods: It was a Randomized Controlled Trial. Data was collected from University of Lahore Teaching Hospital, physical therapy department. Group A- High Intensity Program and Group B- Low Intensity Program each had 42 patients in them. They were all male and female, between the ages of 35 and 65, and had osteoarthritis of different grades, according to Kallgren and Lawrence. The SARC-F questionnaire was used to find out if people had sarcopenia. The outcome measures were pain, functional disability, as well as range of motion.

Results: Group A had a mean age of 58.47 years (SD = 4.22) and a mean symptom duration of 3.47 (SD = 1.82). In contrast, Group B had a slightly higher mean age of 58.8 years (SD = 3.11) and a mean symptom duration of 3.04 (SD = 1.68). At baseline, no significant differences were seen between Group A and Group B in terms of knee range of motion, KOOS pain, KOOS function, and KOOS quality of life. However, after 8 weeks, all variables showed significant differences ($p>0.05$) except for knee flexion ($p>0.05$).

Conclusion: Low-intensity exercises showed greater improvements in pain, functional disability, quality of life, and range of motion compared to the high-intensity group among knee osteoarthritis patients with sarcopenia. Notably, knee flexion exhibited superior enhancement within the high-intensity exercise regimen.

Keywords: Functional disability, Osteoarthritis, Pain, Physical therapy, Progressive resisted exercises, Range of motion, Resistance training, Sarcopenia

INTRODUCTION

Osteoarthritis (OA), a degenerative joint disorder, stands as the preeminent cause of disability globally. The knee, being the largest hinge joint, consists of ossified structures, ligaments, and a synovial membrane which secretes synovial fluid, crucial for lubricating and nourishing the avascular cartilage. Given the substantial strain exerted on this joint, it frequently succumbs to OA, a condition characterized by discomfort and impaired function (1). Knee OA is dichotomized into primary (non-traumatic or idiopathic) and secondary forms, the latter often stemming from mechanical misalignment or trauma (2).

In Asia, the incidence of OA fluctuates between 13.1% and 17.1%, while approximately 40 million individuals in Europe grapple with knee OA (3). In the United Arab Emirates, arthritis is estimated to affect 20% of the population, with a mere 6000 cases formally diagnosed (4). In Pakistan, the prevalence of knee OA is reported to be between 29.7 and 37.0 per 1000 individuals (5)(Khan et al.,

Journal of Health and Rehabilitation Research JHRR 2791-156X

2019). There exists a gender disparity in the prevalence of knee OA, with men experiencing a lower incidence than women, particularly post 55 years of age, where women demonstrate a more severe form of the disease. The incidence in women over 50 is notably higher, ranging from 44% to 70% (6).

Knee OA significantly diminishes quality of life, manifesting as pain, restricted mobility, and morning stiffness. The pain, exacerbated by physical activity, typically subsides with rest. In advanced stages, synovitis may develop, leading to discomfort at rest or nocturnally (7). Symptoms include swelling, joint pain, stiffness, and limited mobility impacting activities like walking, stair climbing, and bending (8). Sarcopenia, defined as an "age-related decline in muscle mass, coupled with diminished muscle strength and/or physical performance" (9), is an irreversible skeletal muscle condition characterized by rapid deterioration in muscle function and atrophy (10). It affects up to 29% of community-dwelling adults over 65 years (11). The SARC-F, a 5-item self-report questionnaire, assesses sarcopenia risk based on individual perceptions of limitations in falling, stair climbing, rising from a chair, strength, and walking ability (12).

Individuals with OA are at an elevated risk for developing sarcopenia, partly due to the increase in inflammatory cytokines, a commonality in both conditions. This association is particularly pronounced in OA affecting the lower limbs (13). Non-surgical interventions for knee OA include intra-articular injections, weight management, NSAIDs, and platelet-rich plasma (14). Total knee arthroplasty is recommended for cases where articular surface involvement reaches grades IV or V (15). Muscle strengthening exercises targeting major muscle groups around the knee, such as knee extensors, hip abductors, and knee flexors, along with aerobic exercises, swimming, and neuromuscular training are beneficial (16). Other treatments include low-level laser therapy, acupuncture, orthoses, thermotherapy, braces, and kinesio taping, which have shown superior outcomes in knee OA management.

Exercise is advocated for individuals with knee OA to mitigate pain and enhance functional status. Studies suggest that high-intensity training or physical activity may confer greater health benefits than lower intensity regimens (17). High-intensity rehabilitation programs typically encompass a warm-up focusing on various muscle groups and functional weight-bearing exercises (18).

This study aims to examine the effects of low and high-intensity progressive resistance exercises on individuals with knee OA concomitant with sarcopenia. By preserving muscle mass, the study seeks to impede disease progression, alleviate joint cartilage degradation, diminish discomfort, and enhance the quality of life of patients. This research endeavors to bridge a gap in the literature by proposing a novel approach to concurrently manage osteoarthritis and sarcopenia, potentially yielding benefits in patients' strength and muscle mass.

MATERIAL AND METHODS

This study, a single, assessor-blind, randomized clinical trial, was conducted in the Physical Therapy Department of the University of Lahore Teaching Hospital. It included 84 patients aged between 35 and 65 years, adhering to the criteria set forth by (19). Participants were those diagnosed with osteoarthritis ranging from grade I to III and also exhibiting sarcopenia. The sample size was determined using pain as the outcome measure, calculated to be 35 in each group. After factoring in a 20% potential dropout rate, this number increased to 42 per group.

Equation 1 Sample Size Estimation Formula

$$n = \frac{2\sigma^2 (z_{1-\alpha/2} + z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

The study's statistical parameters were set as follows: a 95% level of significance (Z1-α/2), an expected mean change in pain of 4.0 for Group A (20) and 5.0 for Group B, with standard deviations of 1.8 and 1.1, respectively. The power of the study (Z1-β) was established at 80%.

Ethical considerations were rigorously followed, including approval from the Institutional Review Board of the University of Lahore (Reference MSPTM02193024). Informed written consent was obtained from all participants. The trial was registered on clinicaltrials.gov (NCT05190380). Eligible cases of osteoarthritis with sarcopenia were referred to the Physical Therapy Outpatient Department of the University of Lahore Teaching Hospital by orthopedic surgeons. Upon confirmation of eligibility and receipt of consent, participants were randomly assigned to two experimental groups using a lottery method.

The intervention for both groups involved exercises such as hip adduction and abduction leg presses, and knee extension exercises, with warm-up sets of 1 repetition maximum and a 2-minute rest between sets (21)(Phals. Group A underwent a high-intensity program, progressively increasing resistance training from 50% of 1 Repetition Maximum (1RM) in the first week to 80% 1RM by the eighth week, varying the number of sets and repetitions each week. Group B followed a low-intensity program, starting with 20% of 1RM and gradually increasing to 40% 1RM by the eighth week, also with variations in sets and repetitions. Both groups received

conventional therapy, including hot packs, TENS, and deep friction massage, twice weekly for eight weeks, with each session lasting 45 minutes.

The outcome measures used were functional disability (Knee Injury & Osteoarthritis Outcome Score, KOOS), pain (Numeric Pain Rating Scale), and range of motion (Universal Goniometer) (22). These measures were recorded at baseline and at the end of the eighth week (23).

Data analysis was conducted using SPSS version 26. Quantitative data such as age, height, weight, pain score, and range of motion were presented as mean ± SD, while categorical data like gender, functional disability, pain intensity, and BMI were displayed as frequency (percentage). After confirming the normal distribution of the data, the Paired sample t-test was used for comparing the outcomes at two intervals (before and after intervention). The Independent sample t-test was utilized to evaluate within-group differences, with p-values of 0.05 or less deemed significant.

RESULTS

In the comparative analysis between the two groups, Group A demonstrated a marginally higher male representation (52.4%) compared to females (47.6%), while Group B exhibited a converse gender distribution, with females constituting 52.4% and males 47.6%. Socioeconomically, Group A predominantly comprised individuals from the upper class (45.2%), whereas Group B had a more significant representation from the middle class (50%). Educational qualifications varied across both groups; Group A displayed a diverse educational background, with the majority holding either matriculation (35.7%) or graduation (23.8%) degrees. In contrast, Group B predominantly consisted of graduates (38.1%). Residential backgrounds also differed, with Group A mainly hailing from rural areas (64.3%), while Group B exhibited an equal distribution between rural and urban residents (50% each). Regarding body mass index, Group A had a 100% prevalence of overweight and obese individuals, whereas Group B comprised a larger portion of overweight and obese individuals (73.8%) compared to those with a normal BMI (26.2%). Knee involvement was comparably distributed in both groups, with the most common affliction being right-sided (33.3%), followed by left-sided (38.1%) and bilateral involvement (33.3%).

Table 1 Frequency table of gender, socioeconomic status, qualification, residence, body mass index and affected side.

Variable	Construct	Group A		Group B	
		Frequency	Percentage	Frequency	Percentage
Gender	Male	22	52.4%	20	47.6%
	Female	20	47.6%	22	52.4%
Qualification	Middle	8	19.0%	10	23.8%
	Matric	15	35.7%	9	21.4%
	Inter	9	21.4%	7	16.7%
	Graduation	10	23.8%	16	38.1%
Body Mass Index	Overweight	34	81.0%	31	73.8%
	Obese	8	19.0%	11	26.2%
Affected Side	Right	14	33.3%	14	33.3%
	Left	16	38.1%	14	33.3%
	Bilateral	12	28.6%	14	33.3%

The demographic characteristics showed that Group A had an average age of 58.47 years (SD = 4.22) and an average symptom duration of 3.47 years (SD = 1.82). Group B, on the other hand, exhibited a slightly higher mean age of 58.8 years (SD = 3.11) and a mean symptom duration of 3.04 years (SD = 1.68).

Pain assessment, using the Numeric Pain Rating Scale (NPRS), revealed that Group B experienced a more pronounced reduction in pain from baseline to the 8th week compared to Group A. By the 8th week, Group A showed a notable improvement in knee flexion with a greater mean difference. In terms of knee extension range of motion, both groups presented similar outcomes, but the mean difference slightly favoured Group B. When analyzing the Knee Injury & Osteoarthritis Outcome Score (KOOS) parameters, Group B demonstrated a higher mean difference for KOOS Pain, KOOS Function, and KOOS Quality of Life from baseline to the end of the intervention period. However, the differences in means between the groups were modest, and the standard deviations were nearly equivalent for both groups. Overall, Group B showed better outcomes in terms of pain reduction, functional improvement, and quality of life enhancement. At the study's outset, there were no significant differences between Group A and Group B regarding.

Journal of Health and Rehabilitation Research 2791-156X JHRR

Table 2 Descriptive statistics of age, duration of symptoms, pain, knee range of motion and KOOS score

Groups	Age		Duration of symptoms	
	Mean	Std. Deviation	Mean	Std. Deviation
High Intensity-Group A	58.47	4.22	3.47	1.82
Low Intensity-Group B	58.8	3.11	3.04	1.68
	Pain (NPRS) at Baseline		Pain (NPRS) at 8th Week	
High Intensity-Group A	7.07	.837	4.85	1.20
Low Intensity-Group B	6.85	.871	3.59	1.16
	Knee flexion at Baseline		Knee flexion at 8th Week	
High Intensity-Group A	51.7	1.80	57.3	2.36
Low Intensity-Group B	52	2.02	56.5	2.45
	Knee extension at baseline		Knee extension at 8th Week	
High Intensity-Group A	7.28	2.09	9.04	.986
Low Intensity-Group B	6.47	2.32	8.28	1.65
	KOOS Pain at Baseline		KOOS Pain at 8th Week	
High Intensity-Group A	37.7	4.78	49.7	5.75
Low Intensity-Group B	37.4	4.65	54.7	4.56
	KOOS Function at Baseline		KOOS Function at 8th Week	
High Intensity-Group A	46.7	4.35	59	4.69
Low Intensity-Group B	47	4.44	63.5	4.51
	KOOS QOL at Baseline		KOOS QOL at 8th Week	
High Intensity-Group A	40	3.28	53.3	3.75
Low Intensity-Group B	39.8	3.25	55.5	3.84
Knee range of motion, KOOS pain, KOOS function, and KOOS quality of life. However, post-intervention (8 weeks), significant differences emerged in all these variables (p>0.05), except for knee flexion (p>0.05).				

Table 3 Mann Whitney U test for knee ROM and KOOS pain, function, Quality of Life

Groups	Mean Rank	P value	Mann-Whitney U	Mean Rank	P value	Mann-Whitney U
	Knee flexion at Baseline			Knee flexion at 8th Week		
Group A- High intensity resistance training	40.68	0.488	805.5	46.39	0.140	718.50
Group B- Low intensity resistance training	44.32			38.61		
	Knee extension at Baseline			Knee extension at 8th Week		
Group A- High intensity resistance training	46.64	0.116	708	48.02	0.031	650
Group B- Low intensity resistance training	38.36			36.98		
	KOOS Pain at Baseline			KOOS Pain at 8th Week		
Group A- High intensity resistance training	43.29	0.767	849.000	32.63	0.000	467

Groups	Mean Rank	P value	Mann-Whitney U	Mean Rank	P value	Mann-Whitney U
Group B- Low intensity resistance training	41.71			52.37		
KOOS Function at Baseline				KOOS Function at 8th Week		
Group A- High intensity resistance training	41.44	0.690	837	32.05	0.000	443
Group B- Low intensity resistance training	43.56			52.95		
KOOS QOL at Baseline				KOOS QOL at 8th Week		
Group A- High intensity resistance training	42.93	0.871	864	36.51	0.024	630
Group B- Low intensity resistance training	42.07			48.49		

Intragroup analysis using the Wilcoxon signed-rank test disclosed significant improvements in KOOS Pain, KOOS Function, and KOOS Quality of Life from baseline to the 8th week within both groups. The mean ranks for these outcomes remained consistent at 42.50 for both baseline and the 8th week, underscoring substantive enhancements in pain levels, functional capabilities, and overall quality of life during the study.

Table 4Wilcoxon Signed Ranks Test for KOOS pain, function, Quality of Life.

Variable	Mean Rank	Wilcoxon Sign Test	P value
KOOS Pain at 8th Week - KOOS Pain at Baseline	42.50	1370.500-1752.000	0.000
KOOS Function at 8th Week - KOOS Function at Baseline	42.50	1346.000- 1740.500	0.000
KOOS Quality of Life at 8th Week - KOOS Quality of Life at Baseline	42.50	1533.500- 1767.000	0.000

DISCUSSION

This research delved into the dynamics of knee osteoarthritis in individuals exhibiting grades I to III severity, with a particular focus on pain levels prior to the intervention. The participant demographics were meticulously analyzed, considering variables such as gender, BMI, educational background, and the knee affected, with frequency and percentage meticulously calculated for each category. The study discerned a significant interaction between time and treatment groups (A and B) in relation to the Visual Analogue Scale (VAS) and the Knee Osteoarthritis and Outcome Score (KOOS), with pain identified as a determinant in a dependent lifestyle, reduced physical activity, and increased apprehension among participants. Clinical characteristics were standardized pre-intervention, leading to no notable differences in baseline characteristics.

The demographic analysis revealed average ages of 58.47±4.22 in Group A and 58.83±3.11 in Group B. Among female participants, 81.0% in Group A and 73.8% in Group B were categorized as overweight, while 19.0% in Group A and 26.2% in Group B were classified as obese. These findings align with a study by Renata T et al. (2014) that reported mean ages of 61.7 ± 6.4 in Group A and 59.9 ± 7.5 in Group B, with average BMI for women in Group A at 30.6 ± 5.75, compared to 31.4 ± 4.42 in Group B, irrespective of group allocation. A separate clinical trial focusing on manual physical therapy and knee exercises over eight weeks reported a 56% improvement in the total WOMAC score, encompassing pain, stiffness, and physical function (24).

In terms of the KOOS Pain scale, the experimental group scored 56.5±14.8, while the control group scored 63.3±12.4. The scores for daily living function were 65.0±14.0 for the experimental group and 74.2±13.9 for the control group, with knee-related quality of life at 37.1±14.2. An observed correlation between the KOOS quality of life and Spearman's rho (-0.27, P=0.06) was noted. This study involved a randomized and controlled design, with participants engaging in supervised exercise thrice weekly for 12 weeks, demonstrating improved pain outcomes (22, 24). The current clinical trial showed a mean rank of 42.50 for KOOS function, pain, and quality of life at baseline with a P-value of 0.00, indicating significant improvements post an eight-week single-blinded treatment session.

A study by Renata T in 2014 evaluated 1RM values across four exercises in experimental and control groups. The extension values were 8.2 ± 4.8 for the experimental group and 5.9 ± 3.7 for the control group, with flexion values at 6.8 ± 2.5 and 5.6 ± 2.9, respectively, showing significant differences (24, 25). In the current study, Group A underwent high-intensity resistance training

Journal of Health and Rehabilitation Research 2791-156X JHRR

(score of 40.68), while Group B received low-intensity training (score of 44.32), with no significant difference in outcomes (P = 0.488). Baseline knee flexion measurements showed scores of 46.64 for Group A and 38.36 for Group B in knee extension after eight weeks, albeit without significant difference (P = 0.116).

Knee osteoarthritis management involves medical treatment, lifestyle modifications, and physical therapy. Exercises can enhance strength and confidence, allowing for increased frequency or resistance in workouts (26). However, muscle weakness may exacerbate knee pain and accelerate osteoarthritis progression. The efficacy of strength training for knee osteoarthritis patients with sarcopenia remains underexplored, particularly due to limitations in sample size and the methodology of single assessor blinding. Larger, more comprehensive studies employing diverse outcome measures are warranted. Administering the KOOS questionnaire can be challenging, requiring significant time and resources. Home-based exercise therapy could serve as a preventive measure against sarcopenia and mitigate symptoms of knee OA.

CONCLUSION

In conclusion, the study found that low-intensity exercises led to greater improvements in pain, functional disability, quality of life, and range of motion compared to high-intensity exercises. Interestingly, knee flexion

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Journal of Health and Rehabilitation Research 2791-156X JHRR

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