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Role Of Functional Training Versus Resistance Training In Knee Osteoathritis Population- A Comparative Study

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ABSTRACT

Background: Knee osteoarthritis (OA) is a prevalent degenerative joint disorder affecting over 250 million individuals globally. It is characterized by progressive cartilage degeneration, joint space narrowing, osteophyte formation, and synovial inflammation, leading to chronic pain, reduced mobility, and decreased quality of life, especially in elderly populations. Conservative, non-pharmacological approaches such as exercise therapy are widely recommended for early and mid-stage OA management. Two frequently employed interventions are resistance training (RT) and functional training (FT), each with distinct objectives—RT aims to build muscle strength and reduce joint load, whereas FT focuses on improving real-world mobility, balance, and neuromuscular coordination. However, comparative data on their relative efficacy in OA rehabilitation remains limited.

Objective: This study aimed to compare the therapeutic effects of functional training and resistance training in individuals with knee OA, with a focus on pain reduction, joint function, and quality of life improvements.

Methodology: A total of 60 participants with clinically diagnosed knee OA were randomly divided into two equal groups: Group A (Functional Training + Standard Exercise) and Group B (Resistance Training + Standard Exercise). The interventions were administered over a structured rehabilitation period, and outcomes were measured pre- and post-intervention using the Visual Analogue Scale (VAS) for pain and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for functional assessment. Age and gender-based sub-analyses were conducted.

Results: Both interventions yielded statistically significant improvements in VAS and WOMAC scores ($p < 0.05$). However, the functional training group demonstrated greater reductions in pain and superior improvements in physical function compared to the resistance training group across most age and gender subgroups. Functional training also resulted in better postural control and real-life mobility outcomes.

Conclusion: While both exercise modalities effectively reduced symptoms and improved function in knee OA patients, functional training proved more beneficial in enhancing dynamic movement, balance, and task-specific performance. These findings support the incorporation of functional training as a preferred conservative intervention in knee OA rehabilitation protocols. Further research is warranted to explore long-term effects and feasibility in diverse patient populations.

Keywords: *Knee osteoarthritis, functional training, resistance training, physical therapy, pain management, WOMAC, VAS, mobility, conservative treatment.*

1. INTRODUCTION

Knee osteoarthritis (OA) is among the most prevalent and disabling musculoskeletal disorders globally, affecting over 250 million people and contributing significantly to chronic pain, physical dysfunction, and reduced quality of life, particularly in the aging population [1]. OA is characterized by progressive degeneration of articular cartilage, formation of osteophytes, synovial inflammation, subchondral bone remodeling, and narrowing of the joint space, leading to joint instability, stiffness, and mobility limitations [2].

According to the World Health Organization, osteoarthritis is the second leading cause of musculoskeletal disability worldwide, following only low back pain [3]. Radiographic studies suggest that nearly 30% of individuals over 60 years old exhibit signs of knee OA, while 10–15% experience clinical symptoms such as joint pain, swelling, crepitus, stiffness, and difficulty with weight-bearing tasks [4]. The condition poses substantial personal and societal burden due to its chronic nature and functional implications.

Multiple risk factors contribute to the development and progression of knee OA, including aging, obesity, female sex, prior joint trauma, malalignment, repetitive mechanical stress, and muscular weakness—particularly of the quadriceps [5]. As the disease advances, biomechanical stress on the knee joint increases due to compromised shock absorption and altered neuromuscular control, further accelerating joint degeneration and impairing function [6].

While pharmacological treatments may offer temporary relief and surgical interventions like total knee arthroplasty are reserved for severe cases, conservative interventions—especially therapeutic exercises—remain central to early and mid-stage OA management [7]. Evidence-based clinical practice guidelines recommend structured exercise therapy as a first-line, non-invasive approach to mitigate symptoms and slow functional decline.

2. BACKGROUND

Among conservative strategies, two primary exercise modalities are frequently employed in OA rehabilitation: resistance training (RT) and functional training (FT). Each approach targets different aspects of musculoskeletal health and movement capacity.

Resistance training focuses on strengthening muscles surrounding the knee joint—most notably the quadriceps, hamstrings, and hip stabilizers—to reduce joint load, increase mechanical support, and enhance functional performance [8]. Studies have demonstrated that RT can promote muscle hypertrophy, improve tendon resilience, and optimize joint mechanics, contributing to symptom reduction and mobility improvement [9]. It has also been associated with decreased inflammation and better outcomes in obese individuals at high risk of OA progression [10].

In contrast, functional training emphasizes movement patterns that closely replicate everyday activities, such as stair climbing, sit-to-stand transfers, and balance tasks. This type of training integrates multiple muscle groups in coordinated, task-specific motions, enhancing postural control, neuromuscular efficiency, and proprioception—qualities often compromised in individuals with OA [11]. FT is particularly relevant for older adults and patients with mobility impairments, as it targets functional independence and fall prevention.

Despite the effectiveness of both modalities, direct comparisons between them remain limited. Some studies suggest RT may better improve strength and muscle mass, while FT may yield greater gains in dynamic stability and real-world mobility [12]. However, due to practical limitations such as time constraints and clinical feasibility, determining the superior approach for OA management is essential for optimizing care delivery.

Hence, this study aims to evaluate and compare the relative efficacy of functional training and resistance training in improving pain, physical function, and quality of life among individuals with knee OA, providing evidence to inform targeted, cost-effective rehabilitation strategies.

3. NEED OF THE STUDY

Osteoarthritis is a major cause of chronic pain and physical disability, particularly in the elderly population, with knee OA being the most frequently affected joint. Despite its high prevalence and socioeconomic impact, there remains a lack of consensus regarding the most effective conservative treatment strategies to delay disease progression and enhance functional outcomes [13]. While pharmacological and surgical treatments exist, these are often associated with side effects, complications, or limited accessibility, making exercise-based interventions essential for long-term management.

Resistance training has long been established as an effective method for strengthening periarticular musculature, improving joint stability, and alleviating OA symptoms [14]. Functional training, meanwhile, emphasizes restoring neuromuscular coordination and enhancing real-life performance through task-specific movements, which are critical for maintaining independence and preventing falls in elderly populations [15]. Though both methods have proven efficacy, few studies have directly compared their outcomes in a controlled clinical setting.

With the increasing emphasis on evidence-based, cost-effective, and patient-centered rehabilitation protocols, it becomes

imperative to identify which modality—functional or resistance training—provides greater overall benefit in symptom management and physical function improvement. A clearer understanding of their comparative effectiveness will allow clinicians to tailor exercise interventions more precisely, according to disease severity, mobility limitations, and individual goals [16].

Therefore, this study is warranted to fill the existing research gap by systematically evaluating and comparing the outcomes of resistance training and functional training in individuals with knee osteoarthritis. The findings will help refine rehabilitation protocols, guide clinical decision-making, and improve patient care for a condition that continues to challenge public health systems worldwide.

4. OBJECTIVE OF THE STUDY

The present study was undertaken to evaluate and compare the therapeutic effects of functional training and resistance training in individuals diagnosed with knee osteoarthritis. The specific objectives are as follows:

1. **To evaluate the effect of resistance training** on pain reduction, joint function, and physical performance in patients with knee osteoarthritis.
2. **To assess the impact of functional training** on pain, mobility, balance, and daily activity performance in individuals with knee osteoarthritis.
3. **To compare improvements in clinical outcomes**—including pain levels (VAS), functional status (WOMAC scores), and quality of life—between resistance training and functional training groups.
4. **To determine which intervention strategy** provides superior overall benefit in terms of reducing symptoms, enhancing physical functioning, and promoting independence in individuals with knee osteoarthritis.

5. AIM OF STUDY

The aim of this study is to compare the effectiveness of functional training versus resistance training in reducing pain, improving joint function, and enhancing overall physical performance and quality of life in individuals diagnosed with knee osteoarthritis.

6. RESEARCH HYPOTHESIS

Null Hypothesis (H_0): There will be no significant difference in the effectiveness of functional training and resistance training in improving pain levels, joint function, muscle strength, physical performance, and quality of life in individuals with knee osteoarthritis.

Alternative Hypothesis (H_1): Both functional training and resistance training will lead to significant improvements in pain levels, joint function, muscle strength, physical performance, and quality of life in individuals with knee osteoarthritis. However, functional training will result in greater improvements in real-world mobility, balance, and functional independence compared to resistance training.

7. MATERIALS & METHODOLOGY

Study Design: A comparative, experimental study design was adopted to evaluate and compare the effects of functional training and resistance training in individuals diagnosed with knee osteoarthritis.

Study Setting and Duration: The study was conducted in the outpatient department of physiotherapy at a tertiary care hospital over a period of 6 weeks.

Sample Size: A total of 60 participants clinically diagnosed with primary knee osteoarthritis were included in the study. Participants were randomly divided into two equal groups:

- **Group A (n = 30):** Received functional training.
- **Group B (n = 30):** Received resistance training.

Sampling Technique: Simple random sampling method was used to allocate participants into the two intervention groups to reduce selection bias and ensure comparability.

8. INCLUSION CRITERIA

Participants must meet all the following criteria to be eligible for the study:

1. Individuals aged between 45 to 70 years.
2. Clinically and radiographically diagnosed with knee osteoarthritis (Grade I or II) based on Kellgren-Lawrence criteria.

3. Experiencing knee pain and functional limitation for more than 3 months.
4. Able to walk independently without assistive devices.
5. Willing to participate and provide informed written consent.
6. Stable vital signs with no recent exacerbations of joint symptoms.

9. EXCLUSION CRITERIA

Participants with any of the following conditions will be excluded:

1. History of recent knee trauma or surgery within the past 6 months.
2. Severe knee osteoarthritis (Grade III or IV).
3. Diagnosed with inflammatory joint conditions such as rheumatoid arthritis or gout.
4. Presence of neurological disorders (e.g., stroke, Parkinson's disease) that affect mobility.
5. Uncontrolled hypertension, cardiac conditions, or other systemic illness that contraindicates exercise.
6. Concurrent participation in other physiotherapy or exercise programs during the study.
7. Cognitive impairments or psychiatric conditions that interfere with following instructions.
8. Participants on intra-articular injections or systemic corticosteroids during the study period.

10. OUTCOME MEASURE

Visual Analog Scale (VAS)

The **Visual Analog Scale (VAS)** is a commonly used method to subjectively quantify pain intensity. It is simple, quick, and effective, making it widely applicable in clinical and research settings. The VAS typically consists of a horizontal or vertical line, usually **10 centimeters in length**, anchored by two verbal descriptors at each end—such as **"no pain"** at one end and **"worst imaginable pain"** at the other.

Patients are instructed to mark a point along the line that best represents the intensity of their current pain. The score is then determined by measuring the distance (in millimeters) from the "no pain" anchor to the patient's mark, giving a score between **0 and 100 mm**.

There is ongoing debate regarding the nature of data generated by the VAS—whether it represents **ordinal** or **ratio** level measurements. This classification significantly affects the statistical methods that should be used for data analysis. Traditional statistical approaches may not always be suitable depending on how the scale is interpreted. Therefore, it is essential to apply appropriate statistical techniques that align with the measurement properties of the scale. Recent literature suggests best practices to enhance the reliability and validity of VAS score interpretation.

WOMAC (Western Ontario and McMaster Universities Arthritis Index)

The Western Ontario and McMaster Universities Arthritis Index (WOMAC) is a validated, self-administered tool widely used to assess pain, stiffness, and physical function in individuals with knee and hip osteoarthritis. It comprises 24 items divided into three subscales:

- Pain (5 items): Assesses discomfort during activities like walking, stair use, resting, and standing.
- Stiffness (2 items): Evaluates joint stiffness after waking and later in the day.
- Physical Function (17 items): Measures difficulty in daily tasks such as standing, walking, using stairs, dressing, and household activities.

Each item is rated on a Likert or visual analog scale. Higher total scores reflect greater symptom severity or functional impairment. WOMAC is commonly used in clinical trials and routine care to monitor disease progression and treatment effectiveness**.**

11. INTERVENTION PROTOCOL

All participants will receive supervised physiotherapy sessions **3 times per week for 8 weeks**. Each session will last approximately **45 to 60 minutes**, including warm-up and cool-down. Exercises will be tailored progressively based on individual tolerance and improvement.

12. PROCEDURE

Eligible participants who met all inclusion and no exclusion criteria were randomly assigned into two groups:

Group A: Functional Training Protocol

- **Frequency:** 3 sessions/week
- **Duration:** 45–60 minutes
- **Progression:** Weekly increase in intensity, complexity, and repetitions based on tolerance
- **Pain Threshold for Progression:** No more than 3–4/10 on VAS during or after exercise

Week 1–2: Foundation & Basic Mobility

- *Warm-up:* Marching in place, ankle pumps, step-touch side walking
- *Functional Tasks:* Sit-to-stand, step-ups (4–6 inch), partial forward lunges, heel-to-toe walking, single-leg stance
- *Cool-down:* Breathing control, hamstring and quadriceps stretches

Week 3–4: Intermediate Coordination & Endurance

- *Warm-up:* Dynamic heel kicks, high knees, side steps
- *Functional Tasks:* Sit-to-stand (arms crossed), step-ups with resistance band, tandem walking, obstacle walking, balance board
- *Cool-down:* Static stretches (calf, hamstring, IT band), deep breathing

Week 5–6: Advanced Function & Dynamic Control

- *Warm-up:* Fast-paced walking or marching
- *Functional Tasks:* Step-downs (8-inch), forward/lateral lunges, agility ladder, squats with lifts, dual-task balance
- *Cool-down:* Dynamic and static stretches, deep breathing

Group B: Traditional Resistance Training Protocol

- **Frequency:** 3 sessions/week
- **Duration:** 45–60 minutes
- **Progression:** Gradual increase in resistance, sets, and reps
- **Equipment:** Resistance bands, ankle weights, body weight

Week 1–2: Activation & Low Resistance

- *Warm-up:* Seated leg swings, ankle pumps, light cycling
- *Exercises:* Isometric quadriceps, straight leg raises, seated knee extensions, standing hip abduction, bridging, calf raises
- *Cool-down:* Passive stretching for quads, hamstrings, calves

Week 3–4: Moderate Resistance & Control

- *Warm-up:* Stationary bike, light treadmill
- *Exercises:* Isometric quadriceps, seated knee extensions with ankle weights, hamstring curls with resistance, wall-supported squats, bridging
- *Cool-down:* Muscle-specific stretches

Week 5–6: Advanced Strength & Endurance

- *Warm-up:* Walking or low-resistance cycling
- *Exercises:* Knee extensions with heavier weights, step-ups with weights, partial squats with dumbbells, hip abduction with loops, bridging with band, single-leg calf raises
- *Cool-down:* Static stretching, optional light massage

All outcomes were evaluated pre- and post-intervention using VAS and WOMAC indices. Paired t-tests were applied for intra-group comparisons. Final results were statistically analyzed to determine effectiveness and draw conclusions.

13. RESULTS & TABLES

Table 1: Comparison of Pre and Post VAS Scores Between Groups

Group	Pre VAS (Mean ± SD)	Post VAS (Mean ± SD)	p-value (within group)	p-value (between groups)
Functional Training	7.34 ± 0.84	4.69 ± 0.99	< 0.001 (Highly Significant)	< 0.001 (Highly Significant)
Resistance Training	7.64 ± 0.89	6.12 ± 0.96	< 0.05 (Significant)	–

Table 2: Comparison of Pre and Post WOMAC Scores Between Groups

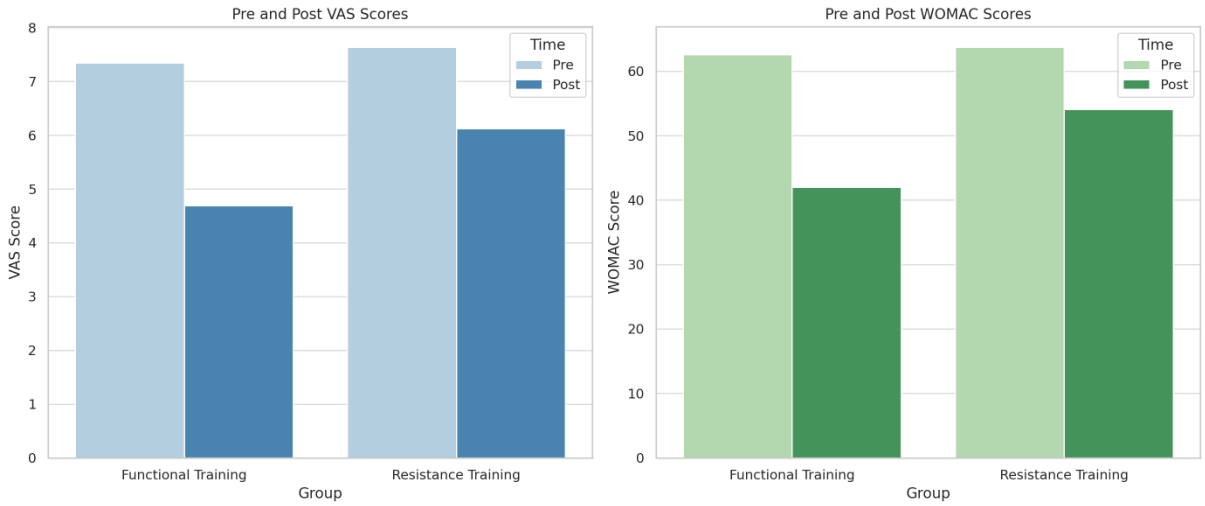
Group	Pre WOMAC (Mean ± SD)	Post WOMAC (Mean ± SD)	p-value (within group)	p-value (between groups)
Functional Training	62.53 ± 7.02	41.98 ± 7.29	< 0.001 (Highly Significant)	< 0.05 (Significant)
Resistance Training	63.74 ± 8.23	54.06 ± 8.69	< 0.05 (Significant)	

Table 4: Gender-wise Comparison in Resistance Training Group

Gender	Pre VAS (Mean ± SD)	Post VAS (Mean ± SD)	Pre WOMAC (Mean ± SD)	Post WOMAC (Mean ± SD)
Female	7.93 ± 0.97	6.46 ± 1.01	64.05 ± 9.80	55.23 ± 10.04
Male	7.48 ± 0.81	5.92 ± 0.90	63.57 ± 7.47	53.38 ± 8.03

Table 5: Age-wise Post-Intervention VAS Comparison Between Groups

Age Group (yrs)	Post VAS - Functional (Mean ± SD)	Post VAS - Resistance (Mean ± SD)
55–59	4.47 ± 0.97	5.78 ± 1.17
60–64	4.88 ± 0.99	6.39 ± 0.71
65–69	4.47 ± 0.88	6.23 ± 1.08
70–74	5.04 ± 1.22	6.02 ± 1.00



The study comprised 60 participants equally divided between the functional training group (Group A) and the resistance training group (Group B), with no significant difference in age distribution or baseline characteristics between the groups ($p > 0.05$).

Pain Levels (VAS): Both groups demonstrated significant reductions in VAS scores post-intervention. Group A showed a greater mean reduction (from 7.34 ± 0.84 to 4.69 ± 0.99; $p < 0.001$), compared to Group B (from 7.64 ± 0.89 to 6.12 ± 0.96; $p < 0.05$). Inter-group comparison revealed significantly better post-intervention pain relief in Group A ($p < 0.001$).

Functional Status (WOMAC): WOMAC scores significantly improved in both groups, with Group A improving from 62.53 ± 7.02 to 41.98 ± 7.29 ($p < 0.001$), and Group B from 63.74 ± 8.23 to 54.06 ± 8.69 ($p < 0.05$). The post-intervention comparison favored Group A with statistically superior functional gains ($p < 0.05$).

Gender- and Age-based Analysis: Both genders and all age groups exhibited improvements in both VAS and WOMAC scores. However, participants in the functional training group consistently reported greater reductions in pain and disability across all age and gender subcategories.

Conclusion from Results: Functional training was more effective than resistance training in reducing pain and improving physical function in individuals with knee osteoarthritis over a 6-week intervention period.

14. DISCUSSION

The findings from this comparative study clearly indicate the benefits of both functional and resistance training in managing symptoms of knee osteoarthritis (OA). However, the functional training group (Group A) demonstrated significantly greater improvements in pain reduction and physical function as measured by both VAS and WOMAC scores.

This aligns with the American Academy of Orthopaedic Surgeons' emphasis on the role of conservative, non-operative treatment strategies in OA, especially in early and moderate stages. The preference for non-pharmacological interventions—particularly exercise—reflects their lower risk profile and long-term effectiveness (1).

The role of demographic and epidemiological trends, as discussed by Hame and Alexander, supports the growing relevance of targeted interventions for knee OA, especially among aging women. The results of our study substantiate the need for accessible, impactful rehabilitation approaches (2).

Roos emphasized the preventative value of exercise and early-stage management over surgical alternatives. Our study validates this notion by demonstrating how functional training—focused on daily task replication—can offer enhanced real-world benefits compared to strength-alone protocols (3).

The impact of obesity as a modifiable risk factor, noted in a 2013 review, reinforces the importance of weight-bearing, low-impact activities in OA. Functional training, by enhancing mobility and physical activity levels, may indirectly contribute to weight control and further joint protection (4).

Blagojevic and colleagues' work on Accelerated Knee OA (AKOA) supports early intervention. Functional exercises that incorporate coordination and balance may help delay AKOA progression through joint stabilization and improved neuromuscular efficiency (5).

Neelapala et al. highlighted hip muscle involvement in knee biomechanics. The functional training group's multidimensional approach likely led to improved hip and knee joint coordination, reducing joint stress (6).

Cookson and Kent's review emphasized orthopedic manual therapy. While our study didn't apply manual therapy, it

reinforces that integrating exercise—especially functional movement patterns—can yield pain relief and functional gains (7).

AbouSawan et al. and Vincent & Vincent both support resistance training's utility in improving joint mechanics, pain, and muscle strength. Our resistance group showed statistically significant improvement, validating these benefits, but functional training showed superior real-life mobility outcomes (8, 20).

Strasser and Schobersberger's focus on obese individuals confirms that resistance training aids musculoskeletal resilience, particularly when traditional aerobic activity is limited (9).

Singh et al.'s RCT on elderly depression further supports the value of progressive resistance in older populations, enhancing lower body strength and mood, both vital in managing OA holistically (10).

Hinman et al.'s evidence of balance issues in OA patients aligns with the design of the functional training protocol, which incorporated dynamic stability tasks for improved proprioception (11).

Publications by Core Health & Fitness and Sam Hopes reinforce that functional exercises are superior in restoring movement patterns, independence, and neuromuscular control in daily life—central themes mirrored in this study (12, 13).

Lee et al. and Donath et al. offer biomechanical backing for low-impact, balance-based approaches such as steppers and Bosu ball training. These principles are embedded in our functional protocol, particularly in weeks 3–6 (14, 15).

Viraj Gandbhir and D. Gould reinforced the utility of objective tools like goniometers and VAS for monitoring joint range and pain. These tools provided reliable metrics for our outcome assessment (16, 17).

Pinskerova and Vavrik's modern understanding of knee kinematics argues for interventions that mimic real joint mechanics. Functional training satisfies this criterion more effectively than isolated resistance exercises (18).

15. CONCLUSION

Both functional and resistance training protocols produced statistically significant improvements in pain and physical function in individuals with knee osteoarthritis. However, functional training demonstrated superior outcomes in terms of real-world mobility, balance, and daily activity performance. This suggests that a task-oriented, neuromuscular training approach may better translate to improved quality of life in OA patients.

The study supports integrating functional exercises in routine rehabilitation protocols for OA management. Functional training not only enhances muscular strength but also addresses balance, proprioception, and task-specific movements vital for patient independence and fall prevention.

16. LIMITATIONS

- Short intervention duration (6 weeks) may not capture long-term effects
- Limited sample size (n=60) reduces generalizability
- Gender representation was not evenly distributed
- No follow-up to assess sustainability of functional gains
- No kinematic gait or imaging analysis was used

17. RECOMMENDATIONS

- Future studies should adopt longer intervention periods and follow-ups
- Incorporate gait analysis and muscle activation monitoring
- Assess combined approaches (functional + resistance) for synergy
- Broaden inclusion to different OA grades and BMI categories

Promote functional training as a core part of OA rehabilitation, especially for elderly populations.

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