The Effects of Different Exercise Intensities in Improving Functional Mobility in Patients with Osteoarthritis of The Knee

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Abstract:
Objective: This randomized controlled trial aimed to evaluate the effects of different exercise intensities on functional mobility, pain, and quality of life in patients with knee osteoarthritis (OA).

Methods: Participants (N=120) were randomly assigned to low-intensity, moderate-intensity, or high-intensity exercise groups. Outcome measures included functional mobility assessments (Timed Up and Go test, 6-minute walk test), pain intensity (Visual Analog Scale), and quality of life (Short Form 36). Assessments were conducted at baseline, 6 weeks, and 12 weeks.

Results: All groups showed improvements in functional mobility and pain reduction over 12 weeks. The high-intensity exercise group demonstrated superior outcomes in functional mobility and pain relief compared to low and moderate-intensity groups.

Conclusion: Higher intensity exercises may offer greater benefits in improving functional mobility and alleviating pain in knee osteoarthritis patients. These findings highlight the potential of tailored exercise prescriptions to optimize rehabilitation outcomes in clinical practice.

Keywords: Knee osteoarthritis, exercise intensity, functional mobility, pain management, randomized controlled trial.

Introduction

Osteoarthritis (OA) of the knee is a prevalent chronic degenerative joint disease characterized by progressive loss of articular cartilage, joint pain, stiffness, and impaired functional mobility (Cao et al, 2020). It affects millions worldwide, significantly impacting quality of life and imposing substantial economic burdens on healthcare systems (Cross et al., 2014). As a leading cause of disability among older adults, effective management strategies are crucial to mitigate symptoms and improve overall function (Cao et al, 2020).

Physical therapy is widely recognized as a cornerstone of non-pharmacological management for knee OA, offering benefits such as pain relief, improved joint function, and enhanced mobility (Bennell et al., 2015; McAlindon et al., 2014). However, the optimal intensity of exercise remains a subject of debate. While low to moderate intensity exercises are commonly recommended for their safety and feasibility, recent studies suggest that higher intensity exercise may provide additional benefits in terms of muscle strength, joint stability, and functional performance (Stevenson and Roach 2012; Fransen et al., 2015)

Despite growing evidence supporting the efficacy of exercise in knee OA management, there remains a need for further exploration into the specific effects of different exercise intensities on functional outcomes such as mobility and physical performance. This study aims to address this gap by conducting a randomized controlled trial (RCT) to compare the effects of low, moderate, and high-intensity exercise interventions on functional mobility in patients with knee OA.

Objectives

The primary objective of this study is to determine whether different exercise intensities lead to varying improvements in functional mobility, as measured by validated outcome measures such as the Timed Up and Go test and the 6-minute walk test. Secondary objectives include assessing changes in pain severity, joint stiffness, and quality of life across the intervention groups.

Rationale for Study

Given the heterogeneous nature of knee OA presentations and individual responses to exercise, understanding the differential effects of exercise intensities is critical for tailoring personalized treatment approaches. By elucidating the impact of exercise intensity on functional outcomes, this study seeks to inform evidence-based recommendations for optimizing exercise prescriptions in clinical practice.

Significance

Findings from this study have the potential to guide healthcare providers in selecting appropriate exercise regimens tailored to individual patient needs, thereby optimizing treatment outcomes and enhancing quality of life for individuals living with knee OA.

Literature Review

Exercise Therapy for Knee Osteoarthritis

Exercise therapy is widely recognized as a cornerstone of non-pharmacological management for knee osteoarthritis (OA), offering significant benefits in pain relief, improved joint function, and enhanced quality of life (McAlindon et al., 2014; Fransen et al., 2015). Various types of exercises, including aerobic, strengthening, and flexibility exercises, have been studied extensively for their efficacy in reducing symptoms and improving physical function in knee OA patients (Bennell et al., 2005; Stevenson and Roach 2012).

Effect of Exercise Intensity

The intensity of exercise plays a crucial role in determining its effectiveness in knee OA management. Low to moderate intensity exercises are commonly prescribed due to their safety and feasibility, targeting improvements in muscle strength, joint flexibility, and aerobic capacity without exacerbating pain or joint damage (Bennell et al., 2015; Fransen et al., 2015). These exercises often form the basis of current clinical guidelines for knee OA management (McAlindon et al., 2014).

High-Intensity Exercise Interventions

Recent studies have explored the potential benefits of higher intensity exercise interventions in knee OA patients. High-intensity exercise programs aim to challenge physiological systems more rigorously, potentially leading to greater improvements in muscle function, joint stability, and overall physical performance (Skou et al., 2015;Hinman et al., 2017). These interventions typically involve activities such as interval training, resistance exercises at higher loads, or combinations of exercises aimed at maximizing physiological adaptations (Dobson et al., 2012;Bricca et al., 2019).

Comparison of Exercise Intensities

Comparative studies examining different exercise intensities in knee OA patients have yielded mixed results. While low to moderate intensity exercises are generally well-tolerated and effective in improving pain and function, some evidence suggests that higher intensity exercises may provide additional benefits, such as greater improvements in muscle strength and functional mobility (Hinman et al., 2014; Wallis et al., 2017).

However, concerns remain regarding the potential for increased joint stress and exacerbation of symptoms in some individuals (Dobson et al., 2012).

Optimal Exercise Prescription

Optimal exercise prescription for knee OA should consider individual patient factors such as disease severity, comorbidities, and functional limitations. Tailoring exercise programs to balance effectiveness with safety is essential, ensuring that interventions are both beneficial and sustainable for long-term management (Bennell et al., 2015; Skou et al., 2015). Multimodal approaches combining different exercise modalities and intensities may offer a personalized treatment strategy that maximizes outcomes while minimizing risks (Skou et al., 2015;Bricca et al., 2019).

In conclusion, physical therapy remains a cornerstone of knee OA management, with exercise intensity playing a critical role in determining therapeutic outcomes. While low to moderate intensity exercises are commonly recommended and effective, higher intensity exercise interventions may provide additional benefits for improving functional mobility and muscle strength. Further research is needed to elucidate the optimal exercise prescriptions and long-term effects of different intensities in knee OA patients.

Methodology

Study Design

This study employed a randomized controlled trial (RCT) design to investigate the effects of different exercise intensities on functional mobility in patients diagnosed with knee osteoarthritis (OA). The RCT design was chosen to minimize bias and provide robust evidence on the comparative efficacy of exercise interventions.

Participant

Participants were recruited from orthopedic outpatient clinics in rehabilitation department at military hospital.
Inclusion criteria included:
- Adults aged 50 years and older.
- Diagnosis of knee osteoarthritis confirmed by clinical examination and imaging.
- Mild to moderate pain and functional limitation due to knee OA.

Exclusion criteria included:
- Severe knee deformities or instability requiring surgical intervention.
- Contraindications to exercise as determined by a healthcare provider.
- Participation in regular structured exercise programs within the past 6 months.

Sample Size Calculation

Sample size was determined based on power analysis using an estimated effect size from previous studies (Bennell et al., 2015; Fransen et al., 2015). A total sample size of 120 participants was calculated to achieve 80% power to detect significant differences between groups, assuming a 5% significance level.

Randomization and Allocation

Participants were randomly assigned to one of three intervention groups using computer-generated random numbers:
1. Low-Intensity Exercise Group: Participants engaged in supervised sessions of low-intensity exercises, focusing on joint mobility and gentle strengthening (e.g., walking, range of motion exercises).
2. Moderate-Intensity Exercise Group: Participants performed supervised sessions of moderate-intensity exercises, including aerobic activities and resistance training at moderate loads (e.g., cycling, leg presses).

3. High-Intensity Exercise Group: Participants undertook supervised sessions of high-intensity exercises, incorporating interval training and resistance exercises at higher loads (e.g., high-intensity interval training, squats).

Intervention Protocols

Each intervention group attended supervised exercise sessions three times per week for 12 weeks, led by experienced physiotherapists. Sessions were tailored to individual participant capabilities and progressed in intensity and complexity over time. Participants were encouraged to continue with home exercises prescribed by the physiotherapists on non-supervised days to promote adherence and continuity of exercise.

Outcome Measures

Outcome measures were assessed at baseline, 6 weeks, and 12 weeks:
- Primary Outcome: Functional mobility assessed using validated measures such as the Timed Up and Go test (TUG) and the 6-minute walk test (6MWT).
- Secondary Outcomes: Pain intensity (Visual Analog Scale), joint stiffness (Western Ontario and McMaster Universities Osteoarthritis Index - WOMAC), and quality of life (Short Form 36 - SF-36).

Data Collection and Analysis

Data on outcome measures were collected by trained assessors blinded to group allocation. Statistical analysis included descriptive statistics, analysis of variance (ANOVA) for between-group comparisons, and repeated measures ANOVA to assess changes over time within groups. Post-hoc tests were conducted where appropriate to identify specific group differences.

Ethical Considerations

Ethical approval was obtained from the ethics committee. Informed consent was obtained from all participants prior to study enrollment, and participants were assured of confidentiality and their right to withdraw from the study at any time without consequences.

Findings

The study evaluated the effects of different exercise intensities on functional mobility, pain, and quality of life in patients with knee osteoarthritis (OA). Participants were randomly assigned to three groups: low-intensity, moderate-intensity, and high-intensity exercise programs. The findings at 6 weeks and 12 weeks are summarized below:

Table 1: Baseline Characteristics of Participants

Characteristic	Low-Intensity (n=40)	Moderate-Intensity (n=40)	High-Intensity (n=40)
Age (years), mean ± SD	65.2 ±7.3	63.8 ±6.5	66.5 ±8.1
Gender (Male/Female)	18/22	20/20	19/21
BMI (kg/m²), mean ± SD	29.1 ±3.5	28.7 ±4.0	30.0 ±3.8
Disease Severity (WOMAC Score), mean ±SD	45.6 ±8.2	46.8 ±7.5	44.5 ±9.0

Table 2: Functional Mobility Outcomes

Outcome Measure	Baseline (mean ± SD)	Week 6 (mean ± SD)	Week 12 (mean ± SD)
Timed Up and Go Test (seconds)			
Low-Intensity	12.5 ±2.1	10.8 ±1.9	9.7 ±1.5
Moderate-Intensity	12.8 ±2.3	10.2 ±1.5	9.0 ±1.3
High-Intensity	13.0 ±2.0	9.8 ±1.7	8.5 ±1.2
6-Minute Walk Test (meters)			
Low-Intensity	320.5 ±45.2	365.8 ±38.6	410.2 ±42.1
Moderate-Intensity	315.0 ±42.8	380.1 ±39.4	425.0 ±40.5
High-Intensity	310.2 ±44.1	390.5 ±37.9	440.6 ±38.8

- Functional Mobility: At both 6 and 12 weeks, all three exercise intensity groups showed improvements in functional mobility, as indicated by reduced Timed Up and Go test times and increased distances covered in the 6-minute walk test. The high-intensity exercise group consistently demonstrated the greatest improvements in both measures compared to the low and moderate-intensity groups. This suggests that higher intensity exercises may lead to more significant gains in mobility over the short term.

- Pain and Quality of Life: Pain intensity, assessed using the Visual Analog Scale, decreased in all groups, with the high-intensity group showing the most substantial reduction. Quality of life measures, including the SF-36 scores, also improved across all groups, with varying degrees of improvement noted in physical functioning, pain interference, and overall well-being.

-Adherence and Safety** Adherence to the exercise programs was high across all groups, with minimal adverse events reported. This indicates that the prescribed exercise intensities were well-tolerated by participants with knee OA, supporting the feasibility of implementing such interventions in clinical settings.

Discussion

Interpretation of Finding

The findings of this study contribute to our understanding of the effects of different exercise intensities on functional mobility, pain, and quality of life in patients with knee osteoarthritis (OA). The discussion will focus on several key points derived from the results:

1. Effectiveness of Exercise Intensities: Our study demonstrated that all three exercise intensity groups (low, moderate, and high) led to improvements in functional mobility, as evidenced by reductions in Timed Up and Go test times and increased distances covered in the 6-minute walk test. These improvements suggest that exercise, regardless of intensity, plays a crucial role in enhancing physical function in knee OA patients (Bennell et al., 2005; Fransen et al., 2015).

2. Superiority of High-Intensity Exercises: Notably, the high-intensity exercise group consistently showed the most significant improvements in functional mobility compared to the low and moderate-intensity groups. This finding aligns with previous research highlighting the potential benefits of higher intensity exercises in promoting muscle strength, joint stability, and overall physical performance in individuals with OA (Hinman et al., 2014; Skou et al., 2015).

3. Impact on Pain and Quality of Lif: Reductions in pain intensity and improvements in quality of life measures were observed across all intervention groups. However, the high-intensity exercise group exhibited the greatest reductions in pain, suggesting that higher intensity exercises may provide superior pain relief benefits in knee OA management (Dobson et al., 2012;Bricca et al., 2019).

4. Adherence and Safety Considerations: The adherence rate to the prescribed exercise programs was high among participants in all three groups, indicating that the interventions were well-received and feasible for individuals with knee OA. Importantly, there were minimal reports of adverse events related to exercise, underscoring the safety and tolerability of the prescribed exercise intensities (Stevenson and Roach 2012;Skou et al., 2015).

5. Clinical Implication: The findings of this study have significant implications for clinical practice. Healthcare providers should consider incorporating higher intensity exercises into tailored rehabilitation programs for knee OA patients, particularly those seeking to optimize functional outcomes and pain management. Multimodal approaches that combine different exercise modalities and intensities may offer personalized treatment strategies that maximize therapeutic benefits (Stevenson and Roach 2012;McAlindon et al., 2014)

6. Limitations and Future Directions: It is essential to acknowledge several limitations of this study, including the relatively short follow-up period of 12 weeks and the need for longer-term assessments to evaluate the sustainability of benefits. Future research should also explore the effects of exercise intensities on specific subgroups of knee OA patients, such as those with varying disease severity or comorbidities, to further refine treatment recommendations.

Conclusion

In conclusion, this study provides evidence supporting the efficacy of different exercise intensities in improving functional mobility, reducing pain, and enhancing quality of life in patients with knee osteoarthritis. While all intensities demonstrated benefits, higher intensity exercises showed superior outcomes in functional mobility and pain relief over the short term. These findings underscore the importance of personalized exercise prescriptions tailored to individual patient needs and preferences in knee OA management.

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