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# Original papers

## Efficacy of physical exercise program in patients with work-related knee osteoarthritis

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## Abstract

Quality of life studies in patients with knee osteoarthritis (OA) attest to the significant impact of the disease on day-to-day activities and social interactions. The aim of this study was to assess the efficacy of a physical exercise program on functional status and quality of life in patients with work-related knee osteoarthritis. The present study included 144 participants with knee osteoarthritis, 72% women, mean age (SD) 47.2 (11.1) years. The patients were randomly assigned in two lots based on the type of kinetic treatment: lot A- with knee OA and medication (72 patients) and lot B- with knee OA, medication and exercise program (72 patients). They followed for 12 days ambulatory exercise programs based on increasing knee flexion, muscular strength and endurance, improving balance, coordination, and respiratory exercises. The patients in the control group continued their daily living activities. The evaluation was made at the beginning of the study (T0), after 2 weeks (T1) and 8 weeks after the 12 days of exercise program (T2) and was based on the following parameters: knee mobility (knee flexion), muscular strength, pain assessment on a Visual Analogue Scale (VAS), functional status (Western Ontario &McMaster Universities Osteoarthritis Index - WOMAC) and quality of life evaluation using SF-36 Questionnaire (36-Item Short Form Survey). Out of 144 participants who completed the initial evaluation, 138 also completed the 2 weeks and the 8 weeks follow-up assessments: 70 patients from the control lot and 68 patients from the exercise lot. The benefits of the kinetic programs were shown by a significant improvement in knee mobility and muscular strength for knee extensors (quadriceps muscle) and knee flexor muscles. Testing the linear correlations between the SF-36 score and the VAS ($r=0.71$, $p<0.05$) and WOMAC ($r=0.83$, $p<0.05$) indicators demonstrates a highly positive relationship between the quality of life expression, the pain assessment score and the functional status score in patients with knee OA. The physical exercise program improves both functional status and quality of life in patients with work-related knee osteoarthritis by increasing the range of motion and muscular strength and by reducing pain.

**Keywords**: *osteoarthritis, knee, quality of life, physical exercise*

## Introduction

Knee osteoarthritis (OA), primarily affects the medial tibiofemoral joint compartment, is a chronic joint disorder that imposes a significant healthcare burden. As there is no cure, traditional management aims to reduce pain, to improve function and to enhance quality of life while minimizing adverse effects of

**Table 1.** Characteristics of the two lots

| Characteristic | Lot A | Lot B | P |
|---|---|---|---|
| Gender (M/F) | 20/50 | 18/50 | NS |
| Age | 44.5 ± 10.2 | 43.9 ± 12.5 | NS |
| Body Mass Index (BMI) | 34.8 ± 4.3 | 34.6 ± 5.1 | NS |

**Table 2.** Patient's distribution in relation to knee flexion

| | T0 | | T1 | | T2 | |
|---|---|---|---|---|---|---|
| Knee flexion | Lot A | Lot B | Lot A | Lot B | Lot A | Lot B |
| 40-60° | 38 | 39 | 27 | 20 | 0 | 0 |
| 60-90° | 21 | 19 | 28 | 26 | 10 | 7 |
| 90-120° | 11 | 10 | 15 | 21 | 45 | 40 |
| 120-140° | 0 | 0 | 0 | 1 | 15 | 21 |
| **Total** | 70 | 68 | 70 | 68 | 70 | 68 |

therapy. Non-pharmacological conservative interventions are considered the first-line approach for symptom management and exercise is recommended by all clinical guidelines [1,2]. Exercise therapy for people with knee OA may take many forms; however, given the fact that muscle weakness is associated with knee OA and that it has a significant impact on pain and function [3], muscle strengthening is a key component of most exercise regimes for knee OA. Recent attention has also focused on whether muscle strengthening can slow disease progression in addition to improving symptoms. Muscle weakness, particularly of the quadriceps, has been recognized as a hallmark of the disease. In addition to the weakness of the quadriceps muscle, people with knee OA also exhibit significant strength deficits of the hip muscles. In a recent study, compared with controls, strength deficits in a group of 89 people with knee OA ranged from 16 % (hip extensors) to 27% (hip external rotators) [4]. Quality of life studies in patients with knee osteoarthritis attest to the significant impact of the disease on day-to-day activities and social interactions. The complex assessment of patients is essential for monitoring the efficacy of various treatments.

The aim of this study was to assess the efficacy of a physical exercise program on functional status and quality of life in patients with knee OA.

## Material and methods

The present study included 144 participants with knee osteoarthritis, 72% women, mean age (SD) 47.2 (11.1) years. The mean duration of knee OA was 7.4 (6.2) years. All patients were diagnosed with knee osteoarthritis based on clinical and imagistic assessment and met American College of Rheumatology diagnostic criteria. All patients included in this study had a stable cardiovascular status. The studied lot was formed from workers who during their professional activities are overloading lower limbs joints and especially the knee: unqualified workers from construction industry who are lifting and transporting weight, packers from clothing industry, unqualified workers from food industry. We excluded from our study the patients with advanced stages of knee OA that required surgical treatment.

The patients were randomly assigned in two lots function of the kinetic treatment: lot A- with knee OA and medication (72 patients) and lot B- with knee OA, medication and exercise program (72 patients). The two lots were comparable statistically concerning demographic and anthropometric characteristics (Table 1). They followed for 12 days ambulatory exercise programs (with a duration of 60 minutes) based on increasing knee flexion, muscular strength and endurance (especially for quadriceps), improving balance, coordination, respiratory exercises. The patients in the control group continued with their daily casual living activities. The evaluation was made at the beginning of the study (T0), after 2 weeks (T1) and 8 weeks after the 12 days of exercise program (T2) and was based on the next parameters: knee mobility (knee flexion), muscular strength, pain assessment on a Visual Analogue Scale (VAS), functional status (Western Ontario &McMaster Universities Osteoarthritis Index- WOMAC) and quality of life evaluation using SF-36 Questionnaire (36-Item Short Form Survey).

## Results

138 of the 144 participants who completed the initial evaluation also completed the 2 weeks and the 8 weeks follow-up assessments: 70 patients from the control lot and 68 patients from the exercise lot. Failure to complete the follow-up assessments was unrelated to the randomized treatment assignment (p=0.657) and between those who did or did not completed the follow-up assessments there were no

**Table 3.** Quadriceps and knee flexors muscular strength at baseline and final evaluation

| Quadriceps muscle strength | T0 | | T1 | | T2 | |
|---|---|---|---|---|---|---|
| | Lot A | Lot B | Lot A | Lot B | Lot A | Lot B |
| F5 | 0 | 0 | 2 | 3 | 10 | 12 |
| F4 | 24 | 29 | 30 | 31 | 37 | 40 |
| F3 | 38 | 36 | 33 | 32 | 23 | 16 |
| F2 | 8 | 6 | 5 | 2 | 0 | 0 |
| **Total** | 70 | 68 | 70 | 68 | 70 | 68 |
| **Knee flexors muscular strength** | **T0** | | **T1** | | **T2** | |
| | Lot A | Lot B | Lot A | Lot B | Lot A | Lot B |
| F5 | 0 | 0 | 0 | 2 | 10 | 12 |
| F4 | 20 | 26 | 29 | 26 | 34 | 34 |
| F3 | 36 | 32 | 33 | 33 | 26 | 22 |
| F2 | 14 | 10 | 8 | 7 | 0 | 0 |
| **Total** | 70 | 68 | 70 | 68 | 70 | 68 |

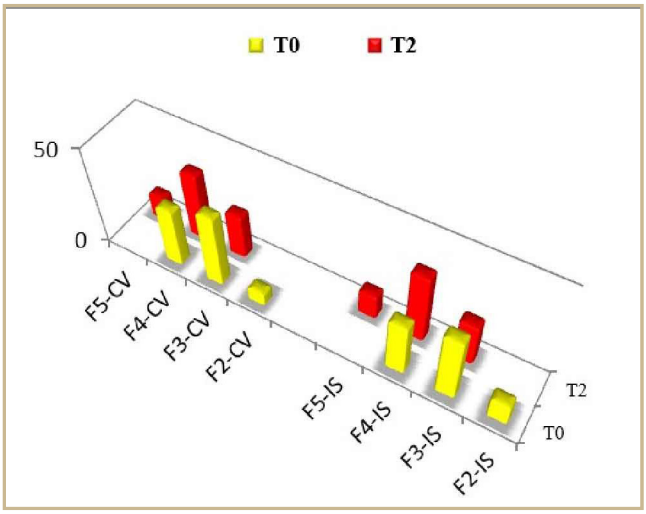


**Figure 1.** Muscular strength improvement in the exercise lot during the 8 weeks of treatment (T0 and T2)

significant differences of any study variables. In the studied lot (with physical exercise program), knee flexion increased from 15% at T0 to 59% at T2, in contrast to the patients from the control lot to whom joint mobility increased from 11% at T0 to 45% at T2 (Table 2). 84% of the patients of the control lot and 89% of the patients of the studied lot (lot B with kinetic treatment) had an increase of the knee flexion over 90°; the functional range of movement of this joint. Table 3 and Figure 1 suggest the muscular strength improvement after 8 weeks for quadriceps and knee flexors. At the baseline assessment of lot B, most of the patients (53%) had a quadriceps strength of 3/5 and 42% of the patients had a quadriceps strength of 4/5; none of the patients had a normal muscular strength. After 2 weeks from the 12 days kinetic program (T1), 45% of the patients presented a muscular force of 4/5 for the quadriceps muscle and 4% of the patients had normal quadriceps strength. After 8 weeks from the exercise rehabilitation program (T2), 59% of the patients presented a quadriceps muscular force of 4/5 and 17% of the patients had a normal muscular strength. At T0, most of the patients (47%) had a muscular strength for knee flexors of 3/5 and 38% of the patients had a muscular force of 4/5; none of the patients had a normal muscular strength for knee joint flexors. Two weeks after the 12 days physical exercise program (T1), 46% of the patients had a 4/5 muscular strength for the knee flexors and 4% of the patients had a normal muscular strength. After 8 weeks (T2), 50% of the patients had a muscular force of 4/5 for knee flexors and 18% of the patients had a normal muscular force. These results suggests the role of exercise program in increasing muscular force in patients with knee OA and implicit in increasing knee stability. There were no statistically significant differences ($p>0.05$) function of the patients gender. The medium score for pain (assessed on a visual analogue scale) did not have significant variations between the two lots: a score of 6.45 for lot A and of 6.44 for lot B ($p>0.05$). After two weeks from the physical-kinetic treatment (T1) it can be noted a significant difference between the two lots: 6.08 for the control lot (lot A) and 5.44 for lot B with physical exercise program ($p=0.004$). There were no statistically significant differences between the two assessments (T1 versus T0, $p>0.05$).

As it is shown in Graph 3, concerning pain assessment on a visual analogue scale (VAS), 66% of the patients in the physical exercise group (lot B) had a score higher than 5 at the initial assessment; at T1 their number decreased at 50% and at T2 the proportion was of only 8%.

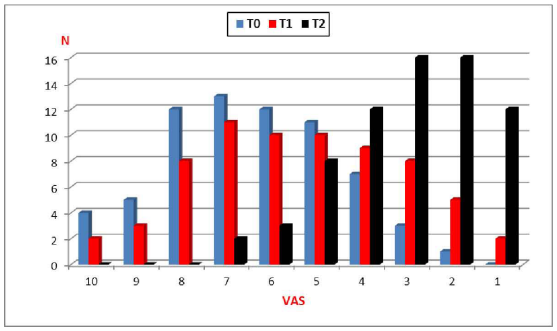


**Figure 2.** Muscular strength improvement in the exercise lot during the 8 weeks of treatment (T0 and T2)

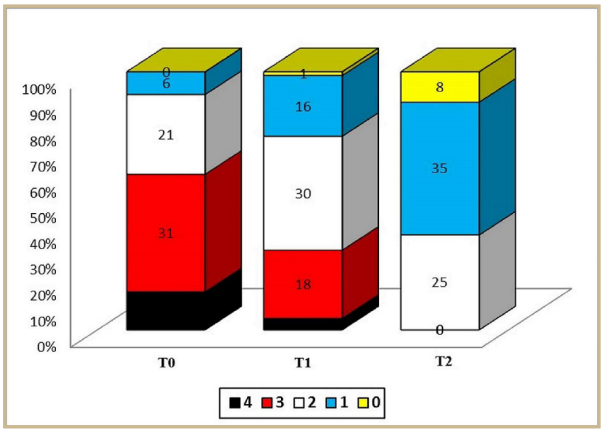


**Figure 3.** WOMAC score evolution in the physical exercise lot

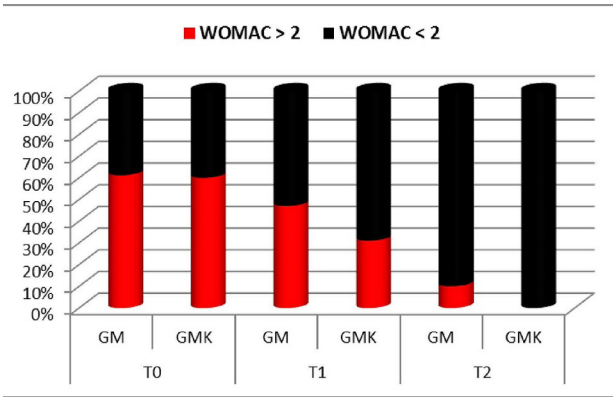


**Figure 4.** The structure of the 2 lots in relation to the treatment and the WOMAC score at the three moments of evaluation

The next figure (Figure 3) demonstrates the functional status improvement represented by WOMAC score during the 8 weeks of the study. At T0, in the physical exercise lot (lot B), 4 patients had a score of 4 points for WOMAC and none of the patients had a WOMAC score=0; at T1 (after two weeks) 3 patients had a WOMAC score=4, one patient had a WOMAC score=1; at T2 (after 8 weeks) none of the patients had a WOMAC score=4 and 8 patients from the studied lot had a WOMAC score=0.

Concerning pain assessment using WOMAC score, at T0 62.3% of the patients from lot A (control lot ) and 60.3% of the patients from the studied lot (lot B) presented a score higher than 2 (moderate). After 8 weeks, most of the patients (90% from the lot A and all patients from lot B) presented a score of 1 (considered low), as shown in Figure 4.

The statistical analysis using the SF36 score demonstrated the role of physical exercise in increasing the quality of life in patients with knee OA. The results after 8 weeks of treatment were statistically significant ($p<0.05$) for all of the SF-36 Questionnaire domains: vitality, physical functioning, body pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning and mental health (Table 4).

As shown in Table 5, testing the linear correlation between SF-36 domains and knee flexion improvement for the studied lots, the results prove weak correlations ($r<0.04$) with most of the domains. Testing the linear correlations between the SF-36 score and the VAS ($r=0.71$, $p<0.05$) and WOMAC ($r=0.83$, $p<0.05$) indicators demonstrates a high positive relation between the quality of life expression, the pain assessment score and the functional status score in patients with knee OA.

## Discussions

The results of this present study point out that physical exercise improved joint mobility, pain, functional status and quality of life in patients with knee OA. It is widely acknowledged that regular physical exercise promotes beneficial effects in many physiologic systems [5]. Physical exercises in knee OA strengthen weak muscles, restore joint motion and treat joint deformity and pain. Moreover, kinetic programs influence mood and socialization, promoting social relationships such as friendship and wellbeing while creating a positive impact on professional activities [6]. Physical exercises may be performed in a variety of modes including isometric, isotonic, isokinetic, concentric and eccentric. They also may be performed in an open kinetic or in a closed kinetic chain manner. Open kinetic chain exercises at the knee are non-weight-bearing, while closed kinetic chain exercises are typically weight bearing involving multiple joints and are thought to be more functional. A meta-analysis published in 2004 identified 22 trials of strengthening exercise on individuals with knee OA employing a variety of modes [7]. The results of this meta-analysis found that resistance exercises were effective in terms of improving pain and function, but there was no evidence that the type of strengthening exercise influenced outcome. Thus, clinicians can prescribe the type of exercise that best suits the individual patient. A more recent systematic review also concluded that resistance training improved pain and function by clinically meaningful amounts in people with knee OA [8]. The effect sizes of physical exercise training are modest but nevertheless similar to those that can be achieved by the use of analgesic drugs and non-steroidal anti-inflammatory

**Table 4.** Evolution of SF-36 domains in the two lots

| SF-36 domains | T0 (baseline) | | T2 (after 8 weeks) | | P | | |
|---|---|---|---|---|---|---|---|
| | Lot A | Lot B | Lot A | Lot B | Lot A2/LotB2 | Lot A0/LotA2 | Lot B0/LotB2 |
| Physical functioning | 44.8±12.3 | 44.7±11.2 | 50.1±11.1 | 56.2±11.5 | 0.0019 | 0.0083 | 0.0001 |
| Physical role functioning | 46.9±20.6 | 45.8±21.1 | 51.2±15.9 | 58.4±20.6 | 0.0228 | NS | 0.0006 |
| Pain | 48.6±21.6 | 48.2±20.9 | 51.4±20.3 | 68.2±19.4 | 0.0001 | 0.0351 | 0.0001 |
| Vitality | 52.4±18.5 | 51.8±18.1 | 58.6±16.6 | 66.3±18.2 | 0.0104 | 0.0384 | 0.0001 |
| Social role functioning | 50.2±30.2 | 51.2±29.3 | 54.3±30.1 | 64.3±26.5 | 0.0404 | NS | 0.0071 |
| General health perceptions | 53.8±21.6 | 53.1±22.4 | 58.3±20.7 | 65.9±23.4 | 0.0451 | NS | 0.0014 |
| Emotional role functioning | 58.9±30.1 | 57.6±27.5 | 61.3±28.9 | 68.2±26.8 | NS | NS | 0.0244 |
| Mental health | 60.3±16.8 | 61.6±17.2 | 63.4±14.6 | 70.2±18.1 | 0.0163 | NS | 0.0052 |
| SF-36 (s/8) | 414.0/8 =50.4±11.8 | 414.0/8 =50.4±11.8 | 448.6/8 =56.6±10.5 | 517.7/8 =64.1±18.1 | 0.0010 | 0.0002 | 0.0001 |

**Table 5.** Testing the linear correlation between SF-36 domains and knee flexion improvement for the studied lots

| SF-36 domains | Pearson correlation coefficient (r) | | | |
|---|---|---|---|---|
| | Knee extension at 180°/s | Knee flexion at 180°/s | Knee extension at 90°/s | Knee flexion at 90°/s |
| Physical functioning | 0.512 | 0.458 | 0.412 | 0.412 |
| Physical role functioning | 0.487 | 0.421 | 0.325 | 0.402 |
| Pain | 0.615 | 0.489 | 0.545 | 0.612 |
| Vitality | 0.411 | 0.335 | 0.389 | 0.311 |
| Social role functioning | 0.214 | 0.199 | 0.227 | 0.687 |
| General health perceptions | 0.361 | 0.387 | 0.235 | 0.213 |
| Emotional role functioning | 0.031 | 0.125 | 0.027 | 0.212 |
| Mental health | 0.252 | 0.178 | 0.211 | 0.478 |

medication [9]. The effects of physical exercise training on different severities of knee OA as well as on other outcomes such as health- related quality of life and depression are yet to be confirmed [8]. One further benefit of resistance training that has been found is an increase in overall habitual physical activity levels [10]. This will be beneficial for general health, particularly given that many people with knee OA are overweight or obese and have a number of co-morbidities such as diabetes and heart diseases [11]. Resistance training is also important to minimize loss of lean muscle mass that would otherwise exacerbate muscle weakness in overweight patients with knee OA undergoing dietary-induced weight loss [12]. There are few long-term studies of the effects of physical exercise training in people with knee OA. A recent study found that a home-based, self-managed program of simple knee-strengthening exercises over a two-year period significantly reduced knee pain and improved knee function in overweight and obese people with knee pain [13]. However, patient adherence to exercise declines rapidly over time and is an important factor in determining the long-term effectiveness of exercise for patients with OA [14]. Adherence is improved when patients receive attention from health professionals rather than following a primarily home-based exercise program [15]. Better adherence is related to patient's belief in the effectiveness of the intervention and his or her understanding of the pathogenesis of OA. Self-efficacy, or belief in one's ability to perform tasks, is also associated with higher adherence and better outcome [16]. The patients included in our study followed an individualized kinetic program and their compliance to physical training was very good: only 6 patients did not complete the study. Eight patients from the physical exercised lot needed to change their place of work due to the increased solicitation of the knee joint during their professional activities.

## Conclusions

The physical exercise program improves both

functional status and quality of life in patients with work-related knee osteoarthritis by increasing range of motion and muscular strength and by reducing pain. Kinetic programs that combine aerobic exercise with exercises for increasing muscular strength and endurance, balance and coordination should be introduced in the rehabilitation programs of patients with knee osteoarthritis without medical contraindications for moderate level exercise.

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