

THE EFFECTS OF PHYSICAL EXERCISE IN OSTEOARTHRITIS OF THE KNEE, NARRATIVE REVIEW

ILEANA STĂNESCU (BOLDEANU)^{1*}, LIGIA RUSU¹

¹University of Craiova, Faculty of Physical Education and Sport, Craiova, Romania

*Corresponding author: ileanaboldeanu@gmail.com

<https://doi.org/10.52846/jskm/43.2024.1.3>

Abstract. Introduction: Knee osteoarthritis is a chronic condition in the category of degenerative joint diseases. The purpose of this narrative review is to conduct an analysis of current approaches regarding the implementation of a functional evaluation and rehabilitation program in knee osteoarthritis. Materials and Methods: The study involved the analysis of a total of 216 articles from the specialized literature selected from the databases Medline, Embase, PubMed, Amed, using keywords: osteoarthritis, gonarthrosis, physical exercises, degenerative joint diseases. Out of the 216 articles, 121 (duplicates) were eliminated. After the selection process, 74 titles were analyzed. Out of 25 eligible papers, only 12 were selected, with the remaining 13 including patients who did not undergo physical exercises. The studies included between 30 and 2957 subjects. Most studies comprised study cohorts divided into 2 - 4 groups. The treatment of subjects was based on performing a program of physical exercises, either in a rehabilitation unit or at home, and the evaluation primarily relied on VAS and WOMAC scales. Results: The results of the studies indicate a 43% reduction in pain and a 44% improvement in functionality. WOMAC scores improved by 52% in the rehabilitation unit groups and by 26% in the home treatment groups. The average VAS was 0.73 for the participating groups in both scenarios of physical exercise programs. Conclusions: The obtained results demonstrate that physical exercise programs lead to a reduction in pain and an improvement in knee functionality.

Keywords: osteoarthritis, gonarthrosis, physical exercises.

Introduction

Gonarthrosis is a chronic degenerative joint disease that causes deterioration of the knee joint cartilage, the appearance of abnormal tissue, reactive changes in the synovial membrane, and the emergence of pathological synovial fluid. In the early stages of the disease, the joint damage often goes unnoticed. (Peat et al., 2001) During the disease process, increased synthesis of the main types of collagen and proteoglycans occurs as a reparative response of chondrocytes. (Dixon et al., 2004) The primary result of the pathological process is the imbalance between collagen synthesis and joint cartilage damage. All causes or processes that lead to cartilage deterioration affect the onset and progression of gonarthrosis. The diagnosis of gonarthrosis is established through clinical and radiological examinations. (Mehrotra et al., 2005).

Gonarthrosis most commonly produces pain and movement limitation. Physiotherapy is a non-invasive treatment method that includes a range of treatment modalities aimed at reducing the symptoms specific to gonarthrosis. There is clear evidence indicating the short-term positive effects of physical exercise within rehabilitation programs, such as pain reduction and restoration of knee joint functionality. Based on the

recommendations of the rehabilitation physician, the training can be individual or group-based, and it has been shown to be very effective in preventing and treating gonarthrosis. (Blagojevic et al., 2010)

In recent decades, numerous studies have demonstrated the efficacy of individual physical therapy applied within the recovery of patients with gonarthrosis. These studies have compared the levels of pain and mobility before and after the rehabilitation therapy, highlighting its importance, especially for active patients who perform sustained physical work daily.

It is well-recognized that regular physical activity and exercises aimed at improving the cardiorespiratory system are associated with general health improvement, increased quality of life, and even reduced cardiovascular or all-cause mortality. Current physical activity guidelines (Physical Activity Guidelines for Americans, 2008) highlight the importance of fitness and physical activity, recommending all adults to engage in at least 150 minutes of moderate-intensity physical exercise or 75 minutes of high-intensity physical exercise weekly. (Gupta et al., 2011)

Data from the Cooper Center Longitudinal Study (Barlow et al., 2016) have shown the contribution

of physical activity to traditional risk factors in cardiovascular disease risk classification.

In a group of 6395 subjects monitored, 420 of them engaged in a single physical activity, namely treadmill running, whose duration was measured. It was observed that the risk of a cardiovascular event was reduced. (Barlow et al., 2016) These data extend previous observations regarding the association of fitness with cardiovascular mortality, suggesting the potential clinical utility of including fitness assessments in cardiovascular risk prediction algorithms. Risk prediction among the general population is challenging because most people have a low risk. The findings of the above-mentioned study suggest that, at least in the short term, fitness evaluation is as useful as most biomarkers and imaging modalities in estimating cardiovascular risk. (Blair et al., 1995)

Physical training, a subcategory of physical activity, is defined as any structured exercise regimen aimed at improving or maintaining cardiorespiratory functionality, muscle strength, health, functional independence, athletic performance, or combinations thereof. Aerobic capacity or cardiorespiratory functionality is typically expressed as mL O₂/kg/min or metabolic equivalents (METs; 1 MET = 3.5 mL/kg/min) and can be directly determined using gas exchange measurements or estimated from the speed achieved on the treadmill, incline percentage and duration (minutes), or from the workload on the bicycle ergometer, expressed in kilograms per minute.

In terms of energy supply, mitochondria and myocyte bioenergetics are important during physical exercise. Increasing exercise intensity and muscle contraction requires a continuous energy supply to maintain Na⁺/K⁺ gradients and conduct calcium ions (a regulator of troponin conformation) for removal from the sarcoplasm of skeletal and cardiac myocytes and to dissociate actin-myosin cross-bridges, thus allowing the muscle to engage in proper contraction-relaxation cycles. Maintaining the health and functionality of mitochondria is vital to mitigate age-related sarcopenia and deterioration of muscle function and efficiency. Consistent aerobic exercise is now widely recognized as a viable and sustainable approach to maintaining mitochondrial health and

functionality, correlating with improved muscle bioenergetics and long-term cardiovascular health. However, the following observations regarding regular exercise are clinically relevant because it:

- Increases the number of mitochondria in myocytes and improves electron transport and oxidative phosphorylation.
- Is associated with lower ROS (reactive oxygen species) production, and consequently, lower oxidative stress levels.

- Increases mitophagy, correlating with increased mitochondrial biogenesis and improved muscle performance. (Wu et al., 2019)

Exercise not only helps maintain muscle strength and mass but also at the cellular level, helps myocytes maintain their ATP biosynthesis capacity and ensure their mitochondrial reserve is optimally functional. Healthier mitochondria may also be less prone to intensifying the oxidative process and triggering myocyte apoptosis.

Continuous physical exercise throughout life mitigates some of the loss of mitochondrial function and health as a person ages. Moreover, it allows for body weight and fat deposits control, prevents the onset of metabolic syndrome, and maintains skeletal muscle insulin sensitivity, with cardioprotective benefits.

Physical Activity Recommendations

The World Health Organization (WHO) 2020 guidelines on Physical Activity and Sedentary Behaviour provide evidence-based public health recommendations regarding the amount (frequency, intensity, duration) and types (aerobic, strength, balance) of physical activity that offer significant health benefits and mitigate health risks (Table 1). (World Health Organization, 2020) Adults are advised to engage in at least 150 to 300 minutes of moderate-intensity aerobic physical activity or 75 to 150 minutes of vigorous-intensity aerobic physical activity, or an equivalent combination of both throughout the week.

In addition to aerobic activities, adults are advised to perform muscle-strengthening activities of moderate or greater intensity that involve all major muscle groups on at least 2 days per week, as these activities provide additional health benefits. (Williams et al., 2007)

Table 1. Recommended daily physical activities for middle aged or older adults based on activity and sedentary behavior guidelines

18-64 years adults	Aerobic activities		Muscle toning activities			Other activities
	Moderate intensity	High intensity	and	At least 2 days	and	
						Additional daily physical activity

	At least 150 mins	or	At least 75 mins				
	Aerobic activities			Muscle toning activities		Other activities	
	Moderate intensity		High intensity			Additional daily physical activity	
65+ adults	At least 150 mins	or	At least 75mins	and	At least 2 day	and	Multicomponent exercises and balance training are recommended
	When not possible, it is recommended to continue aerobic exercises as far as the abilities and physical condition allow						The level of fitness and the ability to safely perform physical activities are taken into account
	Moderate aerobic exercises examples: brisk walking, recreational swimming, slow cycling, doubles tennis						
	High intensity aerobic activities: running, swimming (pool laps), intense cycling (>16 Km/h), singles tennis						

Cardioprotective Mechanisms of Regular Aerobic Exercise and Improvement in Cardiorespiratory Capacity

Cardiorespiratory fitness is a strong predictor of health, highlighting the need for increased awareness of the role of physical exercise in the overall health of patients with inflammatory joint diseases. (Colaco et al., 2020)

The literature supports that age, body mass index (BMI), and self-reported physical activity are associated with cardiorespiratory fitness (measured as VO₂max). It has been shown that there are no significant associations between traditional cardiovascular risk factors, disease progression, and cardiorespiratory fitness in patients with inflammatory joint diseases. According to these studies, self-reported physical activity levels were low, and in 50% of patients, cardiorespiratory fitness was below 80% of the reference values in the general population. Moreover, compared to patients with cardiorespiratory fitness levels that aligned with normal reference values, patients with low cardiorespiratory fitness had a higher BMI, resting heart rate, and triglycerides consistent with HDL-c (High-density lipoprotein cholesterol) and a reduced exercise capacity. (Guazzi et al., 2018)

Cardiorespiratory Fitness and Muscle Fitness

In patients with osteoarthritis, cardiorespiratory fitness can be evaluated using the six-minute walk test. Participants are instructed to walk the maximum possible distance within a 30-meter corridor for 6 minutes, and the total distance

covered is recorded. (Rikli & Jones, 1999) Previous studies (Rikli & Jones, 1998) have found a moderate-to-high correlation between the six-minute walk test, treadmill performance, and maximal oxygen consumption. (Sperandio et al., 2015) The strength of the lower limb muscles can be assessed using the 30-second chair stand test. (Rikli & Jones, 1999) Results below the 20th percentile on the six-minute walk test and the 30-second chair stand test are used to define low cardiorespiratory fitness and low lower limb muscle strength, respectively. Results at or above the 20th percentile on these tests define normal cardiorespiratory fitness and normal muscle strength.

The aim of this paper is to create a narrative review regarding how the implementation and quantification of physical exercise programs have been approached in the literature to improve muscle fitness in individuals diagnosed with gonarthrosis.

Material and Method

The study initially analyzed 216 articles from the specialized literature selected from Medline, Embase, Pubmed, and Amed databases, using keywords: osteoarthritis, gonarthrosis, physical exercise, degenerative joint diseases. Of the 216 articles, 121 were eliminated as duplicates. Of the remaining 95 articles, 21 were excluded because the studies analyzed subjects who had undergone knee replacement surgery. Seventy-four titles were analyzed and reviewed, excluding 49 due to subjects presenting comorbidities associated with

osteoarthritis for which physical effort is limited, and their recovery relied on other types of therapy. Twenty-five papers were eligible, of which only 12 were selected for the present dissemination, while the other 13 included patients who did not benefit from a physical exercise program. The studies included between

30 and 2957 subjects. Most studies comprised groups divided into 2 to 4 subgroups. The treatment of the subjects was based on performing a physical exercise program, either in the rehabilitation unit or at home, and the evaluation was primarily based on VAS and WOMAC scales.

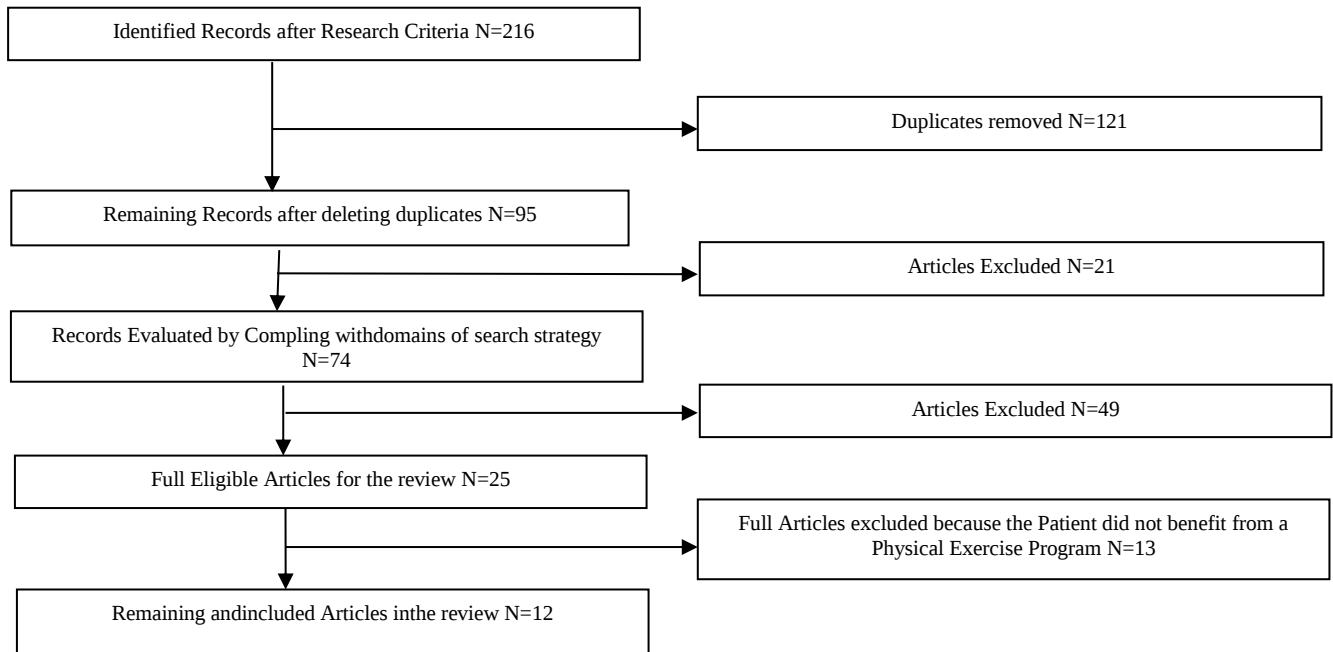


Figure 1. PRISMA diagram of the selection process

Results

The analysis of the response and progress of patients diagnosed with osteoarthritis was based on 12 selected studies from various scientific publications. The analysis considered the number of participants in each study, the duration of the study, the therapeutic approach, evaluation methods, and the results obtained (Table 2).

Table 2: Characteritics of selected studies

Author and publishing year	Number of subjects included in each study	Study duration	Study organization	Therapeutic approach	Evaluation methods	Results
Evcik & Sonel, 2002	90	3 months	30 patient group	Home-based exercise program	VAS, WOMAC	42% improved VAS
						46% improved WOMAC
			30 patient group	walking		40% improved VAS
						45% improved WOMAC
			30 patient group	Medication		25% improved VAS
						38% improved WOMAC

Deyle et al., 2005	134	4 weeks	66 patients group	Clinical treatment	WOMAC, 6 minute walk test	52% improved WOMAC 10% improvement for the 6 minute walking test
			68 patient group	Home based exercise program		26% improved WOMAC 10% improvement for the 6 minute walking test
Petrella & Bartha, 2000	177	8 weeks	88 patient group	Home based exercise+medica tion	VAS, WOMAC	48% improved VAS 50% improved WOMAC
			89 patient group	Medication		35% improved VAS 41% improved WOMAC
Baker et al., 2001	46	4 months	23 patient group	Progressive strenght exercise	WOMAC, VAS, knee extension	38% improved WOMAC 36% improved VAS, 71% improved of knee extension
			23 patient group	medication		21% improved WOMAC, 11% improved VAS, 3% improved of knee extension
Silva et al., 2008	64	18 weeks	32 patient group	hydrokinetotherap hy	VAS, WOMAC	60% improved VAS 45% improved WOMAC
			32 patient group	Indoor physical exercise		42% improved VAS 45% improved WOMAC
Chen & Murphy, 2021	193	6 months	75 patient group	Physical exercises	VAS, WOMAC	65% improved VAS 56% improved WOMAC
			66 patient group			44% improved VAS 36% improved WOMAC

			52 patient group			28% improved VAS 18% improved WOMAC
Ravaud et al., 2004	2957	24 weeks	1479 patient group	medication	VAS, WOMAC	60% improved VAS WOMAC s-a îmbunătățit cu 30%
			1478 patient group	Physical exercise+medication		65% improved VAS 36% improved WOMAC
Wang et al., 2007	38	12 weeks	19 patient group	hydrokinetotherapy	VAS	48% improved VAS
			19 patient group	Indoor physical exercise		31% improved VAS
Hinman et al., 2007	71	6 weeks	36 patient group	Hydrokinetotherapy+medication	VAS	75% improved VAS
			35 patient group	Medication		60% improved VAS
Ferreira et al., 2015	233	3 months	233 patient group	Physical exercise	VAS, Muscle strenght assessment	80% improved VAS, 70% of patients improved muscle strenght
Kasumovic et al., 2013	30	21 days	15 patient group	Electrotheraphy, Massage, medication	VAS	Medium VAS =2,33
			15 patient group	Electrotheraphy, Massage, medication, physical exercise		Medium VAS=0,73
Gwinnutt et al., 2022	50	36 weeks	15 normal weight patient group	Physical exercises	VAS	75% improved VAS in 60% of patients
			35 overweight or obese patient group			30% improved VAS

The study by Evcik & Sonel, (2002) aimed to demonstrate the effectiveness of home exercise and walking programs in the treatment of osteoarthritis. The study group included 90 patients diagnosed with gonarthrosis. Their ages ranged from 48 to 71 years. Patients were divided into three groups, each group comprising 30 patients. The first group benefited from a home exercise program. The second group performed a regular program consisting of walking three times a week starting with a duration of 10 minutes which was gradually increased to 60 minutes. The third group received only analgesic and anti-inflammatory medication. Patients were evaluated according to pain, functional capacity and quality of life parameters. Pain was assessed using the visual analogue scale (VAS), functional capacity was measured using the WOMAC physical function index (Western Ontario and McMaster Universities Osteoarthritis Index) and quality of life was assessed using the Nottingham Health Profile (NHP) questionnaire. All groups carried out the program for three months. At the end of the treatment period WOMAC and VAS scores were statistically lower in the first two groups than in the third group ($P < 0.001$), the difference between groups 1 and 2 not being statistically significant ($P > 0.05$). The NHP score showed a statistically significant improvement in the 2-walking group compared to the 1-exercise and 3-medication groups ($P < 0.001$).

The VAS score improved by 42% for the first group, 40% for the second group and 25% for the third group.

The WOMAC score improved by 46% for the first group, 45% for the second group, and 38% for the third group. As a result, the study shows that a home-based exercise therapy and a regular walking program are effective in treating osteoarthritis symptoms.

The study by Deyle et al., (2005) analyzed 134 subjects with knee osteoarthritis (KO), divided into two groups. The first group included 66 subjects (61% women, 39% men) and benefited from a supervised physical therapy program in a specialized clinic and the second group, which included 68 subjects (71% women and 29% men) conducted a home exercise program.

The purpose of this study was to compare outcomes between a home physical therapy

program and a supervised physical therapy program in a specialty clinic. Subjects in the clinical treatment group performed supervised exercise, individualized manual therapy over a 4-week period. Subjects in the home exercise group had a structured program also over a period of 4 weeks.

The evaluation of the subjects consisted of measuring the WOMAC score and applying the 6-minute walk test before the start of the recovery program and after its completion. Improvements for the WOMAC score were significant. After 4 weeks the WOMAC score improved by 52% in the clinical treatment group and by 26% in the home treatment group. Average 6-minute walking distances improved by approximately 10% for both groups from baseline measurements taken at the start of treatment. Subjects in the clinical, supervised treatment group no longer required analgesic and anti-inflammatory medication for osteoarthritis, and questionnaires showed that they were more satisfied with the results of their recovery treatment compared to subjects in the exercise group. home. The results indicate that subjects in the supervised clinical treatment group achieved a two-fold improvement in WOMAC score compared to subjects who performed similar, unsupervised exercises at home. The study concludes that a home exercise program provides an important benefit for patients with KO, but the application of manual therapy and supervised exercise in the clinic provides a more significant improvement in gonarthrosis symptoms.

The study by Petrella & Bartha, (2000) carried out over a period of 8 weeks compared the effects of a program of physical exercises carried out at home combined with the administration of non-steroidal drugs, with the effects of drug treatment, on pain and physical functionality in patients with unilateral osteoarthritis of the knee. Patients were evaluated at the time of initiation of the rehabilitation program and at the end of it, after 8 weeks of treatment, using the WOMAC score and the visual analog scale, VAS.

The study included 177 patients diagnosed with KO who were divided into two groups. The first group included 88 patients who carried out a home exercise program and were given drug treatment with oxaprozin 1200 mg per os daily. The 89 patients in the second group received the same drug treatment

and in the same dose as the patients in the first group, but did not benefit from physical exercise.

After 8 weeks from the start of the recovery program, an obvious improvement in VAS and WOMAC scores was observed in both groups. These changes were significantly greater ($p < 0.05$) in the group of patients who benefited from physical exercises at home compared to the group of patients who received only medication.

A 48% improvement in VAS score was achieved for patients in the first group and 35% for patients in the second group. The WOMAC score improved by 50% for the first group and by 41% for the second group.

The study authors conclude that the addition of a therapeutic exercise program to nonsteroidal anti-inflammatory drug therapy in patients with KO has the ability to improve scores monitoring pain and function more than drug-only treatment. Baker et al.'s (2001) study demonstrated the effectiveness of a home-based progressive strength training program on the clinical signs and symptoms of KO. 46 patients with knee pain and clear radiographic evidence of osteoarthritis were divided into two numerically equal groups of 23 patients each. The first group was subjected to a progressive strength training program for 4 months and the second group during the same period only benefited from medication. Patients in the first group completed the study with a 71% improvement in knee extension compared to a 3% improvement achieved by patients in the second group ($p < 0.01$). The VAS score improved by 36% and the WOMAC score by 38% for the first group, and for the second group the VAS score improved by 11% and the WOMAC score by 21% ($p = 0.01$ for the comparison between groups). Patients in the first group had an average reduction in pain of 43% and an average improvement in physical function of 44%. The study demonstrated that high-intensity strength training at home can produce significant improvements in strength, physical function, substantial pain reduction, and increased quality of life in patients with KO.

The study by Silva et al. (2008), aimed to demonstrate the effectiveness of hydrokinesitherapy in patients diagnosed with gonarthrosis compared to patients with the same diagnosis who performed physical exercises in the physical therapy room. The

study group included 64 patients who followed an exercise program for 18 weeks. The patients were divided into 2 groups of 32 subjects each, the first group carried out a hydrokinetotherapy program and the second group followed a rehabilitation program based on therapeutic physical exercises practiced in the kinetotherapy room. After 18 weeks of treatment, the patients were evaluated using the VAS visual analog scale to identify the level of pain and the WOMAC score. The final values obtained were compared with the initial values determined at the beginning of the recovery program. The initial VAS and WOMAC scores were close in value in the two groups and the final evaluation determined that the pain decreased significantly and the WOMAC index improved by approximately the same percentage for patients in both groups. In the patients of the first group, the pain decreased considerably more than in those of the second group.

The VAS score improved by 60% for patients in the first group and by 42% for the second group. The WOMAC score improved by approximately 45% for both groups. The analysis of the final results leads to the conclusion that both the hydrokinetotherapy and the exercises carried out in the gym led to a decrease in gonalgias and an increase in the functionality of the knee for all study participants. Hydrokinesitherapy was found to be more effective for knee pain relief for patients with KO in the two groups.

The study by Chen & Murphy (2021), analyzed the effects of therapeutic physical exercise in patients diagnosed with knee arthrosis and who presented different levels of pain (mild, moderate and severe). The study group included 193 subjects aged 50 years or older. The subjects were divided into three groups according to the level of pain: the first group counted 75 patients who reported mild pain, the second group (66 patients) presented moderate pain and the 52 patients in the third group reported severe pain. The three groups were monitored over a period of 6 months, during which they performed physical exercises with a frequency of three sessions per week. At the final assessments, it was observed that the moderate pain group achieved improvements in VAS and WOMAC scores significantly worse than the mild pain group and even better than the severe pain group. The VAS for the first group improved

by 65%, for the second group by 44% and for the third group by 28%. WOMAC improved by 56% for the first group, 36% for the second group, and 18% for the third group. The main conclusion from this study is that the level of pain significantly affects the physical performance and the results achieved through the recovery program in patients with this disease.

The study by Ravaud et al. (2004), took place over a period of 24 weeks and included a number of 2957 subjects diagnosed with arthritic knee pathology, divided into two equal groups, depending on the treatment administered. The subjects in the first group received only non-steroidal anti-inflammatory medication (rofecoxib once a day) and the subjects in the second group benefited from the same drug treatment as those in the first group and in addition performed a physical exercise program with a frequency of 4 sessions per week. The purpose of the study is to demonstrate the beneficial effect of physical exercise added to drug treatment for patients suffering from this syndrome compared to the results obtained by patients who were administered only medication.

At the end of the study, there was an improvement in the functionality of the knee, objectified by the WOMAC score, as well as an obvious decrease in pain, measured on the VAS scale, without recording significant differences between the two groups. For the first group VAS improved by 60% and WOMAC by 30% and for the second group VAS improved by 65% and WOMAC by 36%. The results obtained following the recovery programme tilt the balance in favor of the group that also benefited from physical exercise combined with drug therapy.

The study by Wang et al. (2007) analyzed the effects of hydrokinesitherapy on the change in pain level in patients with gonarthrosis. The 38 participants in the study were divided into two groups of 19 subjects each, the first group performing hydrokinetotherapy and the second physical exercises in the gym. They were evaluated after 12 weeks of recovery treatment using the VAS scale and an improvement of 48% was found for the subjects of the first group and 31% for those of the second group. No adverse effects related to exertion were recorded. This study demonstrates that hydrokinesitherapy is effective even in the short term for patients with KO. Even if the

hydrokinetic therapy program does not lead to substantial relief of pain or its disappearance, the results indicate that it does not deteriorate the condition of the joints and does not worsen the functionality of the knee.

The study by Hinman et al. (2007) aimed to evaluate the effects of hydrokinetic therapy on pain in patients with KO. 71 subjects were divided into two groups (the first group - 36 subjects and the second group - 35 subjects). The first group benefited from hydrokinetotherapy and anti-inflammatory and anti-algesic medication, and the second only with anti-inflammatory and anti-algesic medication, for 6 weeks each. The first group improved their VAS score by 75% and the second by 60%. The running of the rehabilitation program led to a considerable decrease in pain, an increase in joint mobility and a better functionality of the knee of patients affected by osteoarthritis. The effects of the treatment persisted approximately 6 weeks after the completion of the rehabilitation program.

The study by Ferreira et al. (2015), highlighted the effects of exercise in reducing pain and increasing muscle strength in patients diagnosed with KO. The study included 233 subjects who benefited from a three-month recovery exercise program and were assessed at baseline and at the end of the program. A significant decrease in pain and an increase in muscle strength were found in most participants. Thus, 80% of patients showed an improvement in the VAS score and 70% of them obtained an obvious increase in muscle strength, thus also improving knee adduction. Exercise therapy was found to be beneficial in improving KO symptoms for all study participants.

The study by Kasumovic et al. (2013), aimed to demonstrate the effectiveness of the individual physical therapy program within the medical rehabilitation treatment for KO among active, employed patients. The initial level of pain of the patients included in the study was compared with the final level obtained at the end of the therapy. The research included 30 patients diagnosed with this pathology and was conducted at the Institute of Occupational Health and Sports Medicine in Zenica – Dobo Canton, Sarajevo – Bosnia and Herzegovina. Depending on the rehabilitation treatment applied, the patients were divided into two groups and were treated for a period of 21

days. Research has shown that osteoarthritis sets in primarily due to trauma to the knee joint and then as a result of sustained physical exertion and body weight beyond the normal limit.

The patients of the first group (15 people) were given manual massage, electrotherapy and medication based on analgesics and non-steroidal antirheumatic drugs. The 15 patients in the second group benefited from the same type of treatment but in addition they also performed a program of supervised physical exercises. Joint mobility and inflammation were also monitored during the research. Before starting the rehabilitation program, the pain level of the patients included in the research group was assessed using the VAS scale and it was observed that the subjects of the two groups had moderate pain. At the end of the therapy, the pain intensity was evaluated again and it was found that in the patients of the first group the mean VAS value was 2.33 and in the patients of the 2nd group the mean VAS value was 0.73. After data collection, a statistical analysis was performed and the data were presented using tabular or graphical methods. The level of significance was $p < 0.05$. The research achieved its goal by demonstrating that pain levels decreased following exercise therapy, symptoms specific to this disease improved, and subjects in the study group were able to resume physical activity at work.

The study by Gwinnutt et al. (2022), aimed to highlight the consequences of physical exercise and body weight on the results obtained in the rehabilitation process of patients with osteoarthritis of the knee. The 50 patients included in the batch were divided into two groups according to body weight as follows: in the first group 15 normal weight patients were included and in the second group 35 overweight patients or with different degrees of obesity. All underwent exercise-based recovery therapy for 36 weeks. The applied treatment led to the improvement of the VAS score in all patients, but it was observed that the results were worse in those who were overweight or with different degrees of obesity. Thus, 60% of normal weight patients improved their VAS score by 75% and only 40% of overweight or obese patients improved their VAS score by 30%.

The literature advocates exercising and maintaining a healthy body weight for people

diagnosed with this condition. Exceeding normal body weight was associated with poorer outcomes following recovery treatment for patients with gonarthrosis when overweight or obese patients received the same type of therapy as normal weight patients.

CONCLUSION

From the study of the specialized literature, the following findings emerge:

- a recovery program based on well-structured physical exercises carried out daily at home, as well as walking three times a week for periods between 10-60 minutes, gave better results for the patients who followed them than the results obtained by patients who received only analgesic and anti-inflammatory medication. This was proven by the improved results in the VAS score, the WOMAC score, and the increase in quality of life was marked by the improvement in the NHP results, especially in patients who complied with the walking program.
- patients who performed supervised physical exercises at the clinic achieved twice the improvement in WOMAC score compared to patients who performed physical exercises at home.
- a program of therapeutic physical exercises combined with non-steroidal anti-inflammatory medication, in patients with KO, proved to be more effective in reducing pain and improving the functionality of the knee, than therapy based only on the administration of medication, as evidenced by the improvement of VAS and WOMAC scores in -a higher percentage for those who exercised and also received medication.
- high-intensity physical exercises performed at home lead to increased strength, quality of life, considerable pain relief and improved physical function, aspects demonstrated by improved knee extension, VAS and WOMAC scores
- the analysis of the final results for patients who performed hydrokinetotherapy demonstrated that they obtained superior results (assessed by VAS and WOMAC scores) than patients who performed physical exercises at the gym.
- the level of pain negatively influences the physical performance and results achieved by patients with affected knees who follow an exercise-based recovery program. It was observed that patients with moderate pain performed worse than those with mild pain

and better than patients with severe pain. This aspect was highlighted by the evolution of the VAS and WOMAC scores.

- in the case of patients who performed a combined rehabilitation, based on physical exercise and non-steroidal anti-inflammatory medication, the results of the VAS and WOMAC scores were superior to those who received only medication, but without large value differences.

- patients who performed hydrokinetotherapy obtained a more important improvement in the VAS score than those who benefited from physical exercises at the gym. The obtained results indicate that hydrokinetotherapy is also effective in the short term for patients with gonarthrosis and that although it cannot suppress pain, it has the ability to reduce it without damaging the condition of the joints and their functionality

- the effects of hydrokinetotherapy combined with anti-inflammatory and anti-algesic drug treatment were beneficial for patients with this degenerative joint disease. They improved their VAS score by 15 percent more than patients who were given only anti-inflammatory and anti-algesic medication

- exercise therapy led to improvement in KO symptoms, especially pain, muscle strength and knee adduction

- the subjects who benefited from a complex recovery therapy based on the application of massage, electrotherapy, analgesic medication and non-steroidal anti-rheumatic drugs, to which was also added a program of physical exercises supervised in the clinic, managed to reduce their pain level more than the subjects who had followed the same recovery treatment but without doing physical exercises. The improvement of the VAS score, the improvement of the specific symptoms of this disease, allowed the patients who benefited from this type of therapy to regain their ability to work, to return to the workplace.

- the specialized literature promotes the practice of physical exercises and the maintenance of a constant and healthy body weight for patients with knee degenerative disease. It was found that overweight or obese people obtained inferior results and effects to those of normal weight in recovery programs for patients with gonarthrosis.

KO involves, along with the medical aspect, a socio-economic aspect caused by the decrease in work capacity or even the

impossibility of carrying out a physical activity for people diagnosed with this condition. That is why the rehabilitation process of patients affected by osteoarthritis becomes a very important one for reducing pain, increasing functionality, improving the quality of life and implicitly for the recovery of work capacity.

Physical exercise has proven to be a noninvasive therapy method, effective both in the short and long term.

Physical exercise has the advantage that it can be performed both in the clinic and at home and does not involve very high costs. It has been shown that the results of the rehabilitation treatment depend on the degree of damage to the articular cartilage, the age of the subject, the time of diagnosis and the treatment applied.

The sooner recovery therapy is instituted, the better the results. An early diagnosis and individualized and appropriate restorative treatment ensure satisfactory results for patients with osteoarthritis. Patients should be given health education aimed at encouraging them to continue performing physical exercises at home, in a sustained manner, throughout life. By practicing physical exercises, the functional abilities of KO patients to carry out daily activities are significantly improved.

References

- Baker, K.R., Nelson, M. E., Felson, D. T., Layne, J. E., Sarno, R., & Roubenoff, R. (2001). The efficacy of home based progressive strength training in older adults with knee osteoarthritis: a randomized controlled trial. *J Rheumatol* 2001 Jul;28(7):1655-65. PMID: 11469475
- Barlow, E., Shuval, K., Balasubramanian, B. A., Kendzor, D. E., & Kelley, P. G. (2016). Sitting Time, Physical Activity, and Cardiorespiratory Fitness: Cooper Center Longitudinal Study Cohort, *J Phys Act Health*, doi: 10.1123/jpah.2014-0430. 2016 Jan;13(1):17-23
- Blagojevic M, Jinks C, & Jeffery A. (2010). Risk factors for onset of osteoarthritis of the knee in older adults: a systematic

- review and meta-analysis. *Osteoarthritis and Cartilage.*; 18: 24-33.
- Blair, S.N., Kohl, H.W. III., Barlow, C.E., Paffenbarger, R.S. Jr., Gibbons, L.W., & Macera, C.A. (1995). Changes in physical fitness and all-cause mortality: a prospective study of healthy and unhealthy men. *JAMA.*;273: 1093–1098.
- Chen, Y. T., & Murphy, S. L. (2021). Associations of Coexisting Pain and Fatigue Severity with Physical Performance and Quality of Life Among Middle-Aged and Older Individuals with Chronic Knee Pain: Secondary Analysis of a Randomized Clinical Trial. 2021 Nov 26; *Oxford University Press on behalf of the American Academy of Pain Medicine* ;22(11):2575-2583.PMID: 33772557 doi:10.1093/pm/ pnab115.
- Colaco, K., Ocampo, V., Ayala, A.P., Harvey, P., Gladman, D.D., & Piguët, V. (2020). Predictive utility of cardiovascular risk prediction algorithms in inflammatory rheumatic diseases: a systematic review. *J Rheumatol.*;47(6):928–38.
- Deyle, G. D., Allison, S. C., Matekel, R. L., Ryder, M. G. , Stang, J. M., Gohdes, D. D., Hutton, J. P. , Henderson, N. E. , & Garber, M. B. (2005). Physical therapy treatment effectiveness for osteoarthritis of the knee: a randomized comparison of supervised clinical exercise and manual therapy procedures versus a home exercise program, *Physical Therapy and Rehabilitation Journal* 85(12):1301-17. PMID: 16305269
- Dixon, T., Shaw, M., & Ebrahim, S. (2004). Trends in hip and knee joint replacement: socioeconomic inequalities and projections of need. *Ann Rheum Dis.*; 63: 825-830.
- Evciik, D., & Sonel, B. (2002). Effectiveness of a home-based exercise therapy and walking program on osteoarthritis of the knee 2002 Jul;22(3):103-6. doi: 10.1007/s00296-002-0198-7. *Epub* 2002 May 7.
- Ferreira, G.E., Robinson, C.C., Wiebusch, M., de Mello Viero, C.C., da Rosa, M. F., & Silva, L.H.T. (2015). The effect of exercise therapy on knee adduction moment in individuals with knee osteoarthritis: A systematic review. 2015 Jul;30(6):521-7. doi: 10.1016/j.clinbiomech.2015.03.028. *Epub* 2015 Apr 11.
- Guazzi, M., Arena, R., Halle, M., Piepoli, M.F., Myers, J., & Lavie, C.J. (2018). Focused update: clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations. *Eur Heart J.* 2018;39(14):1144–61.
- Gupta, S., Rohatgi, A., Ayers, C. R., Willis, B. L., Haskell, W. L., & Khera, A. (2011). Cardiorespiratory Fitness and Classification of Risk of Cardiovascular Disease Mortality. From the Division of Cardiology, Department of Internal Medicine, University of Texas Southwestern Medical Center, Dallas, Cooper Clinic, Dallas, TX ; and Stanford University, Stanford 2011. *Circulation.* 2011;123:1377-1383. DOI: 10.1161/Circulationaha.110.003236
- Gwinnutt, J.M., Wiecezorek, M., Cavalli, G., Balanescu, A., Bischoff-Ferrari, H.A., Boonen, A., de Souza, S., de Thurah A., Dorner T.E., Moe, R.H., Putrik, P., Rodríguez-Carrio, J., Silva-Fernández, L., Stamm, T., Walker-Bone K., Welling, J., Zlatković-Švenda, M.I., Guillemin, F., & Verstappen, S.M.M. (2022). Effects of physical exercise and body weight on disease-specific outcomes of people with rheumatic and musculoskeletal diseases (RMDs): systematic reviews and meta-analyses informing the 2021 EULAR recommendations for lifestyle improvements in people with RMDs, *RMD Open* 2022 Mar;8(1):e002168. PMID: 35361692 doi: 10.1136/rmdopen-2021-002168.

- Hinman, R.S., Heywood, S.E., & Day, A.R. (2007). Aquatic physical therapy for hip and knee osteoarthritis: results of a single-blind randomized controlled trial. 2007 Jan;87(1):32-43. PMID: 17142642 doi: 10.2522/ptj.20060006. *Epub* 2006 Dec 1.
- Kasumovic, M., Gorcevic, E., Gorcevic, S., & Osmanovic, J. (2013). Efficacy of Physical Therapy in the Treatment of Gonarthrosis in Physically Burdened Working Men, Clinical Center University of Sarajevo, Bosnia and Herzegovina, Medical Faculty University of Sarajevo, Sarajevo, Bosnia and Herzegovina, *AVICENA* 2013, DOI: 10.5455/msm.2013. 25.203-205
- Mehrotra, C., Remington, P.L., & Naimi, T.S. (2005) Trends in total knee replacement surgeries and implications for public health, 1990–2000. *Public Health Rep.* 2005; 120: 278-282.
- Peat, G., McCarney, R., & Croft, P. (2001). Knee pain and osteoarthritis: a review of community burden and current use of primary care. *Ann Rheum Dis.* 2001; 60: 91-97.
- Petrella, R.J. , & Bartha, C. (2000). Home based exercise therapy for older patients with knee osteoarthritis: a randomized clinical trial. *J Rheumatol* 2000 Sep; 27 (9):2215-21. PMID: 10990236
- Physical Activity Guidelines for Americans. U.S. Department of Health and Human Services. (2008). <http://www.health.gov/paguidelines>. Last updated August 21, 2009.
- Ravaud, P., Giraudeau, B., Logeart, I., Laruier, J. S., Rolland, D., Treves, R., Euller-Ziegler, L., Bannwarth, B., & Dougados, M. (2004). Management of osteoarthritis (OA) with an unsupervised home based exercise programme and/or patient administered assessment tools. A cluster randomised controlled trial with a 2x2 factorial design. *Annals of the Rheumatic Diseases* 2004 Jun; 63(6):703-8. PMID: 15140778 doi: 10.1136/ard.2003. 009803.
- Rikli, R.E., & Jones, C.J. (1999). Development and validation of a functional fitness test for community-residing older adults. *J Aging Phys Act.* 1999; 7: 129–161. <https://doi.org/10.1123/japa.7.2.129>
- Rikli, R.E., & Jones, C.J. (1998). The Reliability and Validity of a 6-Minute Walk Test as a Measure of Physical Endurance in Older Adults. *J Aging Phys Act.* 1998; 6: 363–375. <https://doi.org/10.1123/japa.6.4.363>
- Silva, L. E., Valim, V., Pessanha, A. P. C., Oliveira, L. M., Myamoto, S., Jones, A., & Natour, J. (2008). Hydrotherapy versus conventional land-based exercise for the management of patients with osteoarthritis of the knee: a randomized clinical trial. 2008 Jan;88(1):12-21. PMID: 17986497 doi: 10.2522/ptj.20060040. *Epub* 2007 Nov 6.
- Sperandio, E.F., Arantes, R.L., Matheus, A.C., da Silva, R.P., Lauria, V.T., & Romiti, M. (2015). Intensity and physiological responses to the 6-minute walk test in middle-aged and older adults: a comparison with cardiopulmonary exercise testing. *Brazilian Journal of Medical and Biological Research.* 2015; 48: 349–353. <https://doi.org/10.1590/1414-431X20144235> PMID: 25714888
- Wang, T.J., Belza, B., Thompson, F.E., Whitney, J. D., & Bennett, K. (2007). Effects of aquatic exercise on flexibility, strength and aerobic fitness in adults with osteoarthritis of the hip or knee. *Journal of Advanced Nursing* 2007 Jan; 57(2):141-52. PMID: 17214750 doi: 10.1111/j.1365-2648.2006.04102.x.
- Williams, M.A., Haskell, W.L., & Ades, P.A. (2007). for the American Heart Association Council on Clinical Cardiology; American Heart Association Council on Nutrition, Physical Activity, and Metabolism. Resistance exercise in

individuals with and without cardiovascular disease: 2007 update: a scientific statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism. *Circulation* 2007;116(5):572–84. <https://doi.org/10.1161/CIRCULATIONAHA.107.185214>.

World Health Organization. *Guidelines on physical activity and sedentary behaviour*. (2020) Geneva;. Report No.: ISBN: 9789240015128.

Wu, N.N., Tian, H., Chen, P., Wang, D., Ren, J., & Zhang, Y. (2019). Physical exercise and selective autophagy: benefit and risk on cardiovascular health. *Cells* 2019;8(11):1436. <https://doi.org/10.3390/cells8111436>.