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The Effect of a Proposed Rehabilitation Program on Patients with knee Osteoarthritis in the Kingdom of Saudi Arabia

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Abstract

This study aimed to identify the effect of the proposed rehabilitation program on knee osteoarthritis patients in the Kingdom of Saudi Arabia, such as reducing the level of pain and improving the level of knee joint movement, the level of the quadriceps femoris muscle for the anterior and posterior thigh groups, and the degree of ability to perform the overall work of knee osteoarthritis patients. The study used the experimental method for its suitability and the nature of the study as its objectives. The study sample consisted of (10) knee osteoarthritis patients who were intentionally selected from knee osteoarthritis patients. The proposed rehabilitation program was prepared for a period of (8) weeks, with (3) rehabilitation sessions per week. The results of the study showed statistically significant differences in the degree of quadriceps femoris muscle pain for the anterior and posterior thigh groups, as well as the degree of ability to perform mechanical tasks for knee osteoarthritis patients in favor of the dimensional measurement, while there were no statistically significant differences in the level of the knee joint motor index. In light of the results, the study concluded the necessity of using the proposed rehabilitation program such as massage for cases similar to osteoporosis of the knee, and the importance of accelerating early examination of the injury and taking therapeutic measures such as rehabilitation to prevent deterioration of the condition as well as complications.

Keywords: *Knee Osteoarthritis, Rehabilitation Program, Therapeutic Exercises, Pain Reduction, Quadriceps Strength, Saudi Arabia.*

Introduction

Osteoarthritis is a progressive, multifactorial disease characterized by the deterioration of the hyaline cartilage and tissue surrounding the joint. The knee is the joint most affected by osteoarthritis, the most common joint disease in humans. Knee replacement is the preferred

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treatment when osteoarthritis of the knee has reached a severe end-stage, and conservative measures are unable to relieve the patient's pain or restore functional ability [1].

The knee joint is one of the largest joints in the body and is of great importance in walking. It is one of the most complex joints in terms of movement and stability. It is the joint that bears the heaviest loads in the body [2,3]. The knee joint has two opposite functions, the first is the wide movement of the body and the other is carrying the body in a flat pattern. Therefore, the loads and pressures on the ligaments and tendons in the knee increase [4]. The knee joint is one of the joints that are exposed to various and multiple injuries, including knee arthritis, which is one of the common injuries to this joint [5], especially in activities such as games that require rapid movement or a sudden change in direction, such as jumping and other movements, and it can be treated medically or surgically depending on the severity of the injury, or using medications or medical electrical devices such as heat and rays, or using therapeutic exercises, which can be expressed by a set of fixed and moving movements, as a set of concepts such as sports medicine, anatomy, sports training, measurement, testing, and physical therapy, as they are presented to the injured person in order to return the injured part to its normal position, such as restoring its functional function, and it is possible to use comparisons with the help of modern tools that can provide appropriate resistance on the motor path of the injured part, which enhances the speed of the patient's rehabilitation [5,6].

Controlled movement therapy (kinesiotherapy) is considered one of the basic natural methods in the field of integrated treatment of diseases such as injuries [7]. Kinesiotherapy is also of particular importance in the field of rehabilitation, especially in its final stages when implementing occupational therapy in preparation for preparing the case to practice the usual specialized activities after restoring the basic functions of the body of the person suffering from the disease or injury [8]. Therapeutic exercises aim to strengthen the muscles of the injured part to restore full motor function in the joints and restore movement and muscle balance in the injured area so that it can be fully protected, increase muscle efficiency and capacity, eliminate the consequences of the injury, drain blood and prevent inflammation [9]. Therefore, therapeutic exercises are considered among the methods used in treating various injuries [10].

Studies indicate that the prevalence of knee arthritis is high among men at 9% and among women at 18%. The incidence rate increases among men compared to women until menopause [11]. After this age and when a woman reaches menopause, the female reproductive system begins to shrink, leading to joint damage. Therefore, the incidence rate increases among women more than men [11,12].

Recent research suggests that exercise leads to significant improvements in muscle function without adversely affecting disease activity. Studies including radiographic assessment of joint damage as a final criterion have not shown any evidence to support the hypothesis that exercise, even at high intensity, increases inflammation or worsens joint damage [13,14]. However, caution is recommended when applying exercise interventions to patients with severe pain in the early stages of treatment [15]. On the other hand, there is insufficient evidence to suggest a general decrease in physical activity levels in patients or a clear relationship between total physical activity and disease activity [16]. Regarding the effect of exercise on muscle mass, research results show that if the training dose is adequate, a significant increase in muscle mass can be achieved. Therefore, these findings emphasize the importance of designing appropriate training programs that consider the individual condition and needs of patients to achieve maximum benefit. Studies indicate that osteoarthritis of the knee is caused by several factors,

most notably excessive wear, repetitive stress, rheumatic diseases, and injuries [17]. Bow legs are also one of the factors that lead to an unbalanced distribution of pressure on the knee joint, which accelerates the development of osteoarthritis [18]. Therefore, understanding these factors contributes to the development of effective preventive and therapeutic strategies.

Significance of the Study

Osteoarthritis is a leading cause of disability in older adults, and its prevalence, particularly of the hip and knee joints, increases with age. Its prevalence is estimated to be 25% among people aged 65 to 85 years, and 40% of those affected have difficulty performing daily, social, and occupational activities [19]. In the United States, 4.55% of people younger than 50 years have undergone knee replacement, and the number of procedures is expected to reach 3.5 million annually by 2030 [20]. Studies also indicate that osteoarthritis of the knee affects 22.9% of people older than 40 years [21].

The proposed rehabilitation program may improve quadriceps strength in patients with knee osteoarthritis in Saudi Arabia, thereby helping to reduce pain and enhance functional recovery after surgery. The program includes targeted exercises aimed at strengthening muscles and improving range of motion, with the goal of accelerating functional recovery and reducing hospital stay, ultimately leading to lower medical costs. In addition, these exercises play a crucial role in preventing potential complications such as blood clots and muscle atrophy. Therefore, this study aims to evaluate the effect of the proposed rehabilitation program on knee function recovery and overall quality of life of patients after surgery.

Objectives of the Study:

This study aimed to identify:

1. The effect of the proposed rehabilitation program on patients with knee osteoarthritis according to the variable of pain degree.

2. The effect of the proposed rehabilitation program on patients with knee osteoarthritis according to the variable of the kinetic index of the knee joint.

3. The effect of the proposed rehabilitation program on patients with knee osteoarthritis according to the variable of the quadriceps femoris muscle strength of the anterior and posterior thigh groups.

4. The effect of the proposed rehabilitation program on patients with knee osteoarthritis according to the variable of the degree of performing total work.

Study hypotheses

1. There were statistically significant differences at the significance level ($\alpha \leq 0.05$) between the pre-measurement and the post-measurement on the level of the degree of pain among patients with knee osteoarthritis.

2. There were statistically significant differences at the significance level ($\alpha \leq 0.05$) between the pre-measurement and the post-measurement on the level of the motor index of the knee joint among patients with knee osteoarthritis.

3. There were statistically significant differences at the significance level ($\alpha \leq 0.05$) between the pre-measurement and the post-measurement on the level of the quadriceps femoris muscle, anterior and posterior, among patients with knee osteoarthritis.

4. There were statistically significant differences at the significance level ($\alpha \leq 0.05$) between the pre- and post-measurement in favor of the post-measurement on the level of the ability to perform total activities for patients with knee osteoarthritis.

Operational Definitions

Knee joint: It is one of the largest joints in the body and is responsible for movement such as walking and other activities, and consists of the thigh bone, the shin bone, and the patella [22].

Knee arthritis: It is one of the most common bone diseases that affect the knee joint, and it is a disease resulting from the weakness and cracking of the soft cartilage that covers the surfaces of the bones that support the knee joint (thigh bone, shin bone, and patella), and the knee cartilage acts as a soft and flexible cushion that helps with movement [23].

Massage: It is a set of special movements that are based on scientific foundations as an experiment in applying warm doses of mechanical stimulation to the surface of the body to strengthen it and increase its ability to resist, and restore its functions, and the movements are performed by the masseur's hand or by the devices used [24].

Therapeutic exercises: They are physical movements based on scientific medical foundations for therapeutic purposes that aim to stimulate and restore the natural functions of the affected part and maintain its current condition and increase its efficiency.

Literature Review

Physical rehabilitation of all kinds has become synonymous with medical procedures in the prevention and treatment of many diseases and even sports injuries. It has become an important tool that patients must undergo after or before medical procedures to avoid surgical intervention. Researchers have also become increasingly interested in studying the importance of using therapeutic exercises for some diseases that may affect the skeletal system, due to the good results they have observed in this field. Movement is of great importance to the human body, as it reduces the likelihood of disease, and in addition, it achieves self-satisfaction and the ability to perform daily tasks without assistance or dependence on others [25]. From this perspective, many researchers have conducted studies in this context to determine the potential results of therapeutic exercises and motor rehabilitation for multiple joint injuries. One study, Kolasinski et al. (2019), recommended the use of therapeutic exercises as one of the means to reduce joint injuries, particularly the knee joint [26]. Given that the knee joint is a large and complex joint and bears most of the body's weight, this makes it more susceptible to injury due to many factors, including physiological and mechanical factors. Interest in the use of therapeutic exercises and rehabilitation methods for people of all ages, genders, and medical conditions has become widespread, with the goal of alleviating some of the symptoms that affect movement in patients such as those with osteoarthritis [26].

Recent scientific evidence indicates that therapeutic exercise is one of the most effective methods for managing the symptoms of knee osteoarthritis (KOA), as it contributes to reducing pain and improving physical function and quality of life. A study by Fransen et al. (2015) showed that land-based exercises reduced pain by approximately 12 points on a scale of 100 and improved functional performance by 10 points [27]. A systematic review by Henriksen et al. (2016) found that exercise was as effective as analgesics in reducing pain [28]. Yuan et al. (2022) confirmed that most types of therapeutic exercise, whether aquatic, resistance training, or yoga, have proven effective [29].

Furthermore, aquatic exercise is widely accepted, especially among older adults, due to its ability to reduce stress on joints during exercise. A study by Kim et al. (2022) showed that aquatic exercise led to greater pain reduction than land-based exercises [30], while Najafi et al. found that (2020) found that an 8-week aquatic program improved balance and gait more than traditional exercise [31]. According to a study by Slouma et al. (2024), the aquatic group showed a 93% improvement in pain compared to only 33% in the group performing floor exercises [32].

Resistance training is a pivotal component of rehabilitation programs. A systematic review by Tarantino et al. (2024) demonstrated that these exercises lead to significant improvements in pain, muscle strength, and motor function [33]. Exercises such as cycling and yoga have also shown promising results [29].

Al-Tarabani (2022) conducted a study aimed at designing an exercise program accompanied by PRP injections and studying its effect on treating knee osteoarthritis after meniscectomy. The study included 12 players from the Abu Saql Sports Club in North Sinai. The results showed statistically significant differences in favor of the post-test, indicating the program's effectiveness in reducing pain [34]. Ahmed (2021) also found that a rehabilitation program accompanied by cupping therapy led to a significant improvement in muscle strength and range of motion in a group of knee osteoarthritis patients, compared to a control group [35].

Marius's study (2012) also showed that rehabilitation exercises were more effective than traditional drug therapy in reducing pain and improving functional capacity in patients over the age of forty [36]. Blascoe's study (2008) also demonstrated the effectiveness of exercises in a heated aquatic environment in improving muscle strength in patients with rheumatoid arthritis [37].

In Saudi Arabia, Alasfour et al. study (2022) demonstrated that using a mobile application to motivate exercise contributed to reducing pain and increasing adherence in Saudi women with knee osteoarthritis. However, there is a lack of systematic clinical trials evaluating comprehensive rehabilitation programs in the Saudi context [38].

In summary, abundant evidence suggests that exercise therapy whether floor-based strengthening exercises, aerobic fitness, or flexibility exercises—delivers significant improvements in pain, mobility, and quality of life.

Knee Osteoarthritis

Osteoarthritis, also known as wear-and-tear arthritis or osteoarthritis, is a condition in which the cartilage in a joint wears away. When this happens, the bones of the joints rub against each other significantly, causing the cartilage to lose its shock absorption capacity [39]. It is also known as a joint disorder characterized by joint swelling, impaired muscle stability, and functional impairment resulting from the destruction of articular cartilage. Joint pain is often accompanied by joint pain, which usually occurs after using [40].

Knee joint injury occurs when the cartilage in the knee gradually wears away. The disease begins before symptoms are noticeable. The collagen in the joint becomes disorganized, the proteoglycans within the cartilage also decrease, and collagen fibers collapse, leading to an increase in the amount of water in the knee [41]. Inflammation of the synovial membrane, the lining of the joint cavity and the capsule can also occur. The surrounding joint, and other parts within the joint may also be affected. The internal ligaments of the joint become thickened and filled with fibrosis [23]. Knee osteoarthritis is divided into four grades:

- Grade 1: where the patient usually feels no pain.
- Grade 2: This is the most severe grade, where the patient feels intermittent pain and tingling in the knee joint.
- Grade 3: This grade results in bone rubbing against each other and is accompanied by inflammation of the synovial membrane. The surfaces of the knee bones are exposed, and bony prominences appear, accompanied by knee pain.
- Grade 4 is the most severe and dangerous grade of knee osteoarthritis, where the patient feels severe pain in the knee with any movement, and may be accompanied by a tear in the meniscus.

Causes of knee osteoarthritis

There are multiple causes of knee osteoarthritis, and more than one cause may be present in some patients. These causes include [23]:

1. Genetics: Studies have proven the presence of genetic factors in this disease.
2. Obesity: This is one of the most important causes of this disease, as the knee bears most of the body's weight.
3. Age: The incidence increases with age, as cartilage loses its vitality.
4. Repetitive stress on the knee or the nature of the job: such as working for long periods in a bent-legged position.
5. Previous knee injuries, such as bruises.
6. Gender: Women are more susceptible to this condition than men.
7. Weakness of the muscles that support the knee joint.
8. Peak joint mobility.

Knee Osteoarthritis Treatment and Rehabilitation:

Treatment of knee osteoarthritis:

Among the treatment methods that help alleviate symptoms are some medical procedures and medications, such as glucosamine and chondroitin, bisphosphonates, hydroxychloroquine, biologics, stem cell injections, hyaluronic acid injections, platelet-rich plasma, and transcutaneous electrical stimulation [42].

Knee osteoarthritis is a progressive disease, so getting the right diagnosis and treatment as early as possible is key. It should be noted that knee osteoarthritis and osteoarthritis cannot be completely cured, but there are methods that can help alleviate symptoms. In 2019, the American College of Rheumatology and the Arthritis Foundation updated their guidelines for treating and improving the condition of patients with osteoarthritis of the knee. Some of the guidelines are as follows [26]:

1. Weight loss.
2. Following a treatment program using therapeutic exercises.
3. Using a joint stabilizer (CMC) orthosis.

Rehabilitation for Knee Osteoarthritis

Knee osteoarthritis develops due to cartilage loss, and the bone is also affected. This is accompanied by pain. Since pain can make exercise difficult, muscle loss may occur. Rehabilitation intervention is necessary to alleviate symptoms using various physical techniques, such as thermal agents and electrotherapy, in addition to therapeutic exercises and behavioral therapy, either alone or in combination with interventional techniques [43]. One type of rehabilitation is manual therapy, which includes therapeutic exercises. The intervention of a specific physical activity, such as yoga, enhances mind-body harmony through whole-body awareness, which helps the body function by increasing strength, flexibility, and range of motion. Physical activity and exercise may relieve chronic pain (pain that lasts more than 12 weeks) and overall quality of life, while reducing the need for pain medications [44]. The main goal of therapeutic exercises for knee osteoarthritis is self-management of disease symptoms through exercise. This has been confirmed by research, which has clearly shown the effect of these exercises on patients with knee osteoarthritis as well [44,45].

Therapeutic Exercises

Therapeutic exercise is defined as a set of physical exercises performed using standardized movements based on selected scientific measurements. The desired goal is to restore the injured part to its normal or similar state. Therapeutic Exercises defined as specific athletic movements for various medical conditions, with therapeutic and preventative purposes [43]. These movements aim to restore the body to its normal state or rehabilitate it using the basic principles of sensory and motor function, which influence the ability of muscles and nerves to respond by selecting specific movements and appropriate body positions [43,45].

Therapeutic exercise is divided into two categories, as Barker (2021) divided them as follows [26]:

1. Passive exercises: These are movements performed by the therapist or an external force on the patient while their muscles are completely relaxed.

2. Active exercises: These are movements performed jointly by the patient's muscles and the therapist. These are classified, in order of difficulty, as follows:

- Movements assisted by the therapist.

- Free movements performed by the patient themselves.

- Resistance movements, i.e. against resistance from the therapist or any external force, in which the muscles work against a force during contraction or relaxation of the muscle.

Aims of Therapeutic Exercise

The importance of therapeutic exercise is evident in improving patients' condition, maintaining their current level, and preventing deterioration of their health. Furthermore, exercise may improve heart and respiratory function, increase muscle strength, and improve mental health [43]. Therefore, the American College of Rheumatology and the Arthritis Foundation updated their guidelines for improving patient condition, strongly recommending therapeutic exercise [46]. The goals of therapeutic exercise, including:

1. Increasing joint range of motion.

2. Increasing muscle and ligament elasticity and strength.

3. Strengthening the muscles that operate on the knee joint.

4. Balance: Restoring muscles affected by nerve transaction or paralysis to their previous position and regulating their function.

5. Functional training after a long period of inactivity, such as learning to walk or use prosthetic limbs.

Materials & Methods

Study Design and Participants

This experimental study aimed to evaluate the effect of a proposed rehabilitation program on patients with knee osteoarthritis (KOA) in the Kingdom of Saudi Arabia. The study was conducted between March and November 2024. A purposive sampling method was used to select participants from healthcare centers specializing in musculoskeletal rehabilitation.

Written informed consent was obtained from all participants before their inclusion in the study. The study included 10 patients diagnosed with knee osteoarthritis based on clinical examination and radiographic evidence. Participants were selected based on specific inclusion criteria: individuals aged 40 years and above, experiencing moderate to severe knee pain, and willing to participate in the rehabilitation program. Patients were excluded if they had undergone knee surgery within the past six months, had inflammatory arthritis (such as rheumatoid arthritis), or had severe comorbid conditions that could interfere with rehabilitation outcomes.

Treatment Procedure

A proposed rehabilitation program of exercises and massage was prepared for (8) weeks, with (3) rehabilitation sessions applied to patients per week. The duration of one rehabilitation unit was (45) minutes, each session in which several therapeutic exercises were applied (warm-up exercises, rubbing and rubbing massage, from a standing position, the heels off the ground, raise with repetition, from a standing position and leaning on a chair, the right foot behind at a 90-degree angle, from a standing position, extend the leg forward and then backward with alternation, repeating 20 repetitions for each position, from a sitting position on a chair, place a towel between the knees, press the towel and hold for 15 seconds, relaxation exercises, breathing exercises). The researcher relied on scientific foundations to develop the rehabilitation program, considering the rules of warm-up and cooling down, organizing and distributing rehabilitation exercises, and the suitability of the program to the health status of the sample consisting of patients with knee osteoarthritis.

Data Analysis

Data processing was performed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, USA) version 10. The mean and standard deviation of the variables before and after the proposed rehabilitation program were calculated. The Wilcoxon Signed-Rank Test was used to detect the difference between the pre- and post-application of the study tests. The test was re-tested using the paired t-test, and the alpha values were accepted at the probability level of 0.05.

Result

Table (1) shows the demographic characteristics of the participants as a reference for evaluating the effectiveness of the proposed rehabilitation program by age, weight and BMI, with a mean

age of 49.50 ± 6.43 years, indicating the age groups at risk for developing knee osteoarthritis. The mean BMI of 34.23 ± 8.05 kg/m² reflects a high prevalence of obesity, which is a major risk factor for disease progression.

Patient's characteristics	**Mean ± standard deviation**
Age, years	49.50 ± 6.43
Height, cm	78.3 ± 9.26
Weight, kg	78.06 ± 15.42
Body mass index, kg/cm²	34.23 ± 8.05

Table 1. Characteristics of Study Participants

Test Hypothesis:

- **There are statistically significant differences at a significance level of (α≤0.05) between the pre-test and post-test measurements, in favor of the post-test measurement, regarding the pain level in patients with knee osteoarthritis.**

Measurement	**Mean**	**Standard Deviation**	**Z-Value**	**P-value**	**Effect Size %**
Pre-test	4.70	2.00	- 2.07	0.03*	18.70%
Post-test	3.40	1.84			

Table 2.

Comparison of Pain Levels in Patients with Knee Osteoarthritis in the pre- and post-application the Rehabilitation Program Using the Wilcoxon method pairs Signed

(*) Statistically significant at a significance level of (α≤0.05).

Table (2) indicates that the difference in pain levels between knee osteoarthritis patients before and after the intervention is statistically significant at the significance level (α≤0.05), with a calculated Z value of -2.07 and a corresponding p value of 0.03. These results support the research hypothesis, confirming that the applied program had a significant effect in reducing pain levels in patients. The comparative analysis of the average pain scores also supports this conclusion. The average pain level before the program was applied was 4.70, which significantly decreased to 3.40 after the intervention. This decrease demonstrates the effectiveness of the program in alleviating pain. In addition, the effect size was calculated at 18.70%, indicating a moderate effect of the intervention according to traditional effect size classifications. This reinforces the practical importance of the program in improving the condition of knee osteoarthritis patients. Figure (1) shows the differences between pre-test and post-test pain levels, further confirming the decrease in pain after implementing the proposed program.

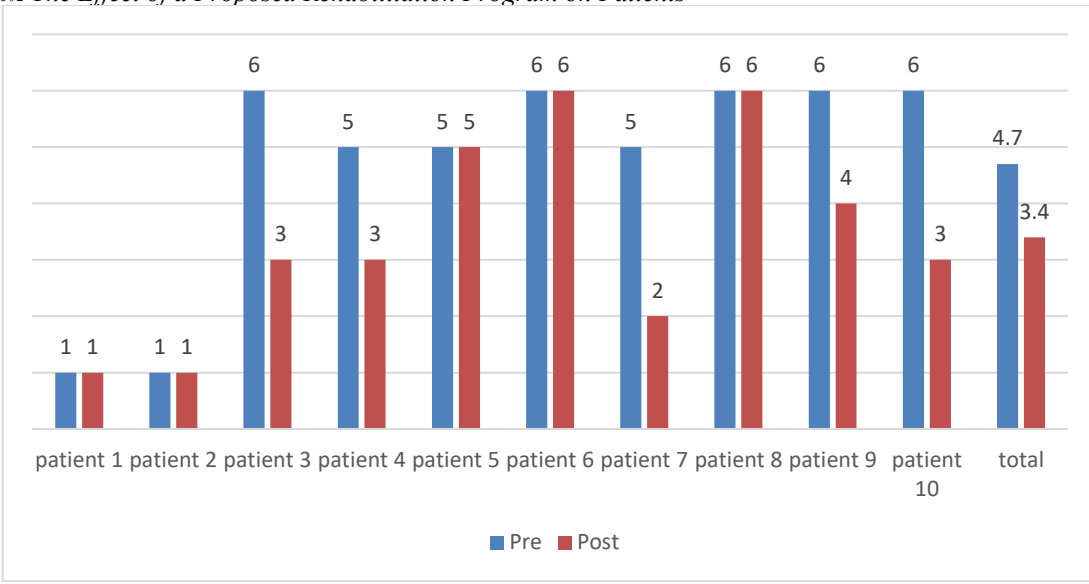

Figure 1. Differences Between Pre- and Post-Application of Pain Score in Patients with Knee Osteoarthritis

- **There were statistically significant differences at the significance level ($\alpha \leq 0.05$) between the pre-measurement and the post-measurement on the level of the motor index of the knee joint among patients with knee osteoarthritis.**

Measurement	Mean	Standard Deviation	Z-Value	P-value	Effect Size %
Pre-test	179.00	2.11	- 1.41	0.157	
Post-test	180.00	0.00			

Table 3.

Comparison of the level of the motor index in Patients with Knee Osteoarthritis in the pre- and post-application the Rehabilitation Program Using the Wilcoxon method pairs Signed

(*) Statistically significant at a significance level of ($\alpha \leq 0.05$).

Table (3) indicate that there were no statistically significant differences between the pre-test and post-test measurements of the motor index of the knee joint among patients with knee osteoarthritis. The computed Z-value of -1.41 and the associated p-value of 0.157 exceed the accepted significance level ($\alpha \leq 0.05$), suggesting that the observed difference is not statistically significant. The mean values also indicate a slight increase in the mobility index from 179.00 in the pre-test to 180.00 in the post-test. However, this change remains marginal and does not indicate a significant improvement in knee joint mobility after the intervention. Figure (2) shows the differences between the pre- and post-test of the motor index of the knee joint.

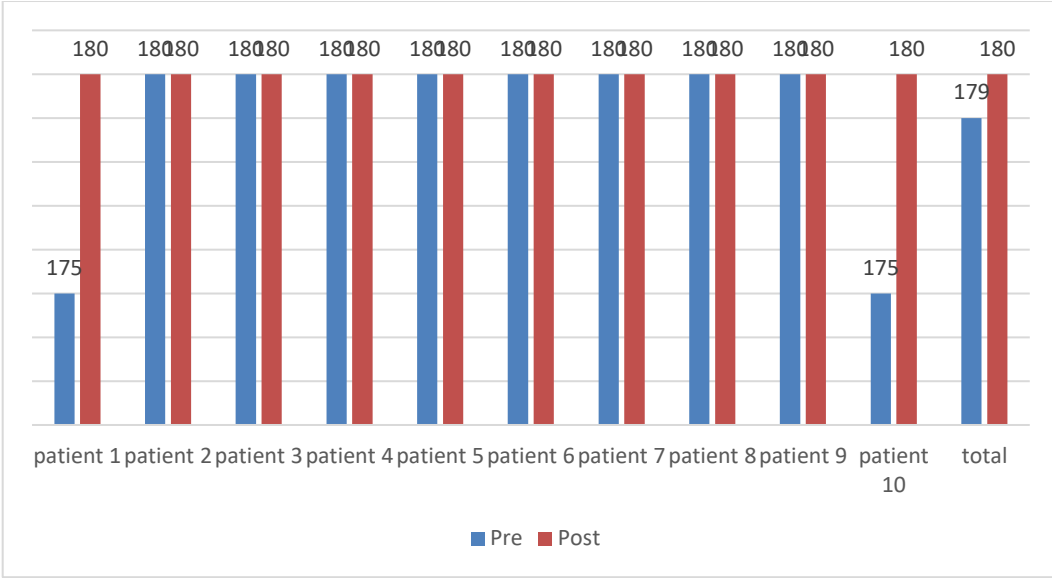

Figure 2.

Differences between pre- and post-application of level of the motor index in patients with knee osteoarthritis

- **There were statistically significant differences at the significance level ($\alpha \leq 0.05$) between the pre-measurement and the post-measurement on the level of the quadriceps femoris muscle, anterior and posterior, among patients with knee osteoarthritis.**

Measurement	Mean	Standard Deviation	Z-Value	P-value	Effect Size %
Pre-test	22.27	7.41	- 2.71	0.00*	23.14%
Post-test	32.72	6.53			

Table 4.

Comparison of the level of the quadriceps femoris muscle anterior in Patients with Knee Osteoarthritis in the pre- and post-application the Rehabilitation Program Using the Wilcoxon method pairs Signed

(*) Statistically significant at a significance level of ($\alpha \leq 0.05$).

Table (4) indicates that there were statistically significant differences between the pre-test and post-test measurements of the quadriceps femoris muscle strength anterior among patients with knee osteoarthritis. The computed Z-value of -2.71 and the associated p-value of 0.00 are below the accepted significance level ($\alpha \leq 0.05$), confirming that the observed difference is statistically significant. The mean values show a notable increase in muscle strength, rising from 22.27 in the pre-test to 32.72 in the post-test. This substantial improvement, with an effect size of 23.14%, suggests that the intervention had a positive impact on the quadriceps femoris muscle. Strengthening this muscle group is crucial for knee joint stability and function, indicating that

the applied intervention may have contributed to enhanced muscle performance and potentially improved knee joint support.

Figure (3) shows the differences between the pre-test and post-test level of the quadriceps femoris muscle anterior.

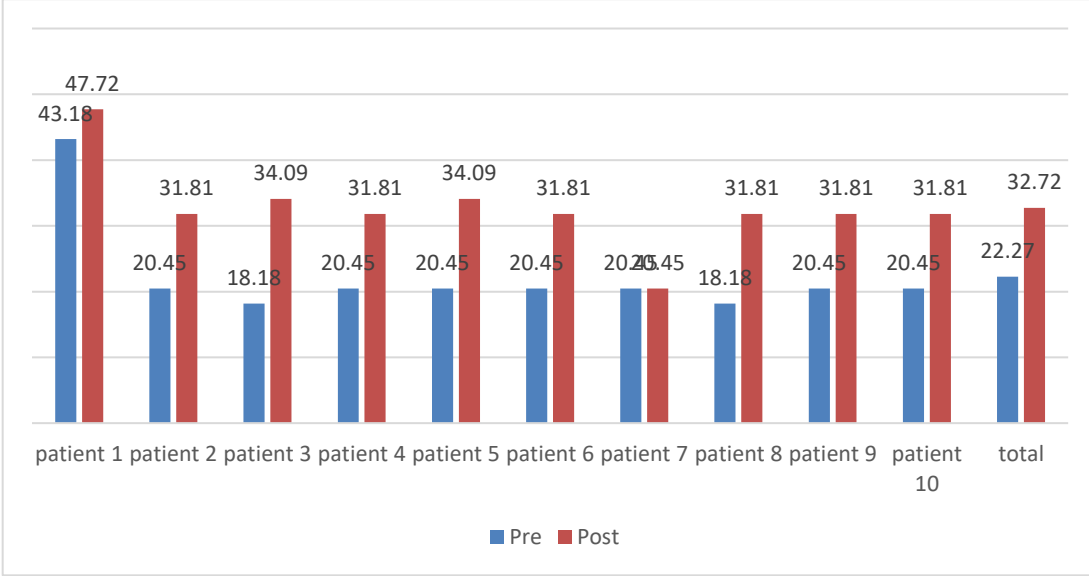

Figure 3.

Differences between pre- and post-application of the level of the quadriceps femoris muscle anterior in patients with knee osteoarthritis

Measurement	Mean	Standard Deviation	Z-Value	P-value	Effect Size %
Pre-test	70.0	13.94	- 2.54	0.01*	22.01%
Post-test	61.0	8.75			

Table 5.

Comparison of the level of the quadriceps femoris muscle posterior in Patients with Knee Osteoarthritis in the pre- and post-application the Rehabilitation Program Using the Wilcoxon method pairs Signed

(*) Statistically significant at a significance level of ($\alpha \leq 0.05$).

Table (5) indicates that there were statistically significant differences between the pre-test and post-test measurements of the quadriceps femoris muscle strength posterior among patients with knee osteoarthritis. The computed Z-value of -2.54 and the corresponding p-value of 0.01 fall below the accepted significance level ($\alpha \leq 0.05$), confirming the statistical significance of the observed difference. The mean values indicate a decrease in measurement, dropping from 70.0 in the pre-test to 61.0 in the post-test. This reduction, with an effect size of 22.01%, suggests

that the intervention had a noticeable impact. Such a change may imply a decline in the measured parameter, which could be attributed to the intervention's influence.

Figure (4) shows the differences between the pre-test and post-test level of the quadriceps femoris muscle anterior.

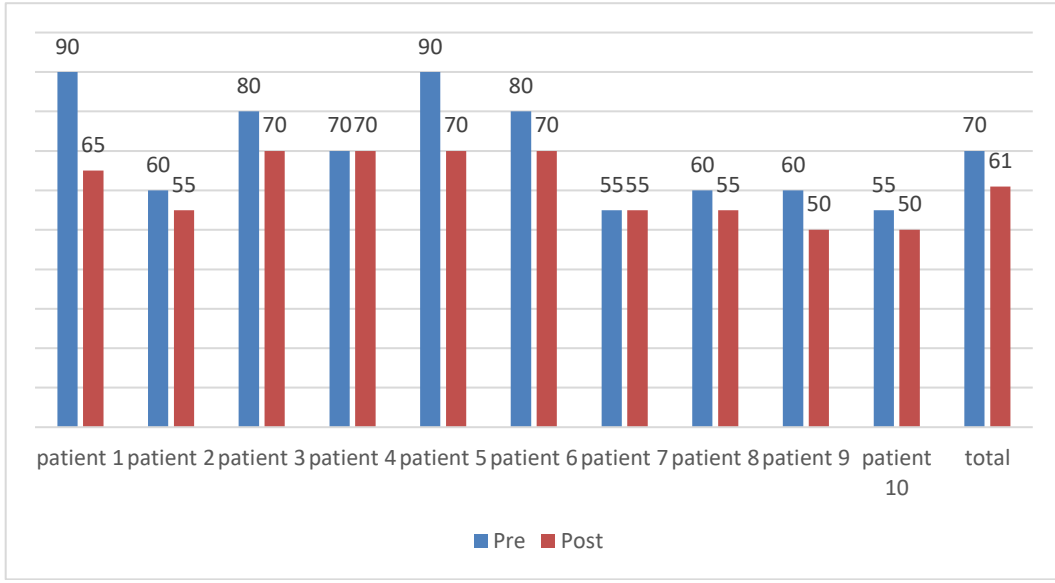

Figure 4.

Differences between pre- and post-application of the level of the quadriceps femoris muscle anterior in patients with knee osteoarthritis

- **There were statistically significant differences at the significance level ($\alpha \leq 0.05$) between the pre- and post-measurement in favor of the post-measurement on the level of the ability to perform total activities for patients with knee osteoarthritis.**

Measurement	**Mean**	**Standard Deviation**	**Z-Value**	**P-value**	**Effect Size %**
Pre-test	1.10	0.31	- 2.82	0.00*	23.86%
Post-test	1.90	0.31			

Table 6.

Comparison of the level of the quadriceps femoris muscle posterior in Patients with Knee Osteoarthritis in the pre- and post-application the Rehabilitation Program Using the Wilcoxon method pairs Signed

(*) Statistically significant at a significance level of ($\alpha \leq 0.05$).

Table (6) indicates that there were statistically significant differences between the pre-test and

post-test measurements of the in favor of the post-measurement on the level of the ability to perform total activities for patients with knee osteoarthritis. The computed Z-value of -2.82 and the corresponding p-value of 0.00 fall below the accepted significance level ($\alpha \leq 0.05$), confirming the statistical significance of the observed difference. The mean values indicate a decrease in measurement, dropping from 1.10 in the pre-test to 1.90 in the post-test. This reduction, with an effect size of 23.86%, suggests that the intervention had a noticeable impact. Such a change may imply a decline in the measured parameter, which could be attributed to the intervention's influence.

Figure (5) shows the differences between the pre-test and post-test level of the in favor of the post-measurement on the level of the ability to perform total activities for patients with knee osteoarthritis.

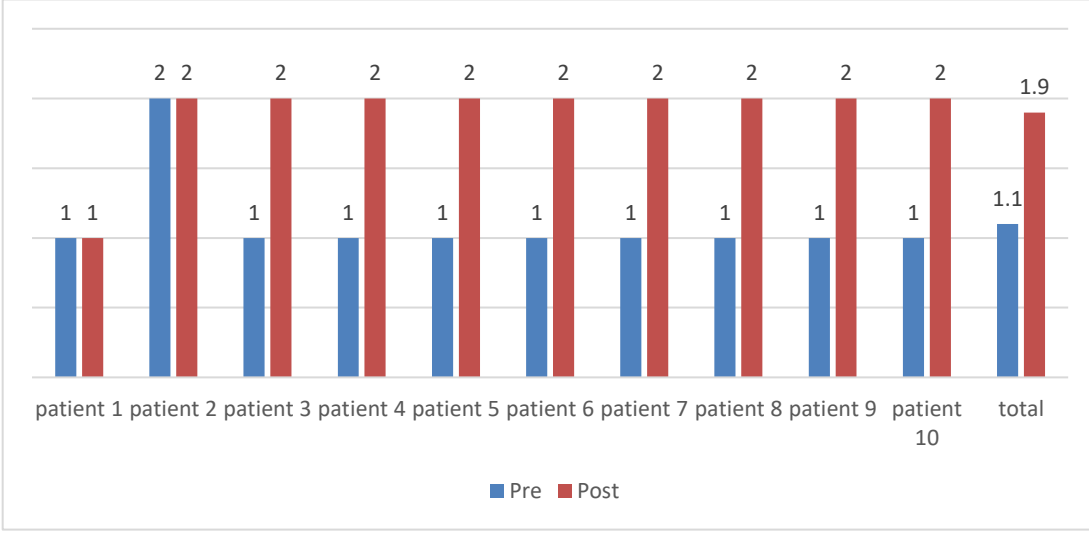

Figure 5.

Differences between pre- and post-application of the level of the in favor of the post-measurement on the level of the ability to perform total activities for patients with knee osteoarthritis.

Discussion

The results of the study confirm the effectiveness of the proposed rehabilitation program in improving functional outcomes, reducing pain levels, improving quadriceps strength, and increasing mechanical work capacity among patients with knee osteoarthritis in Saudi Arabia. However, no significant improvement in the knee joint mobility index was observed, highlighting the need for a more comprehensive rehabilitation approach that includes movement-focused interventions. These results are consistent with previous research while also providing new insights for improving rehabilitation strategies for patients with knee osteoarthritis [47]. The results of the study reinforce the importance of rehabilitation programs for patients with knee osteoarthritis in reducing pain levels. The mean pain score decreased from 4.70 to 3.40 after the intervention, with a p value of 0.03, indicating a statistically significant effect at ($\alpha \leq 0.05$). This reduction in pain can be attributed to the combined effects of therapeutic exercises and massage therapy, both of which play a crucial role in enhancing endogenous pain-

relieving mechanisms. Massage therapy is known to increase endorphin levels and improve blood circulation, thus relieving pain and reducing joint stiffness. These results are consistent with the findings of Iqbal et al (2024) , which demonstrated that structured rehabilitation programs significantly reduce pain intensity in patients with knee osteoarthritis [48]. These results suggest that adopting rehabilitation programs contributes to the management and treatment of patients with knee osteoarthritis [48,49].

In addition to pain management, the study reported statistically significant improvements in quadriceps strength, particularly in both the anterior and posterior muscle groups. Quadriceps anterior strength increased from 22.27 to 32.72 ($p = 0.00$, effect size = 23.14%), while quadriceps posterior strength improved from 70.0 to 61.0 ($p = 0.01$, effect size = 22.01%). This significant increase in muscle strength confirms the effectiveness of resistance-based therapeutic exercises, which included static muscle contractions and elastic resistance bands at varying intensities. These exercises are likely to enhance muscle fiber recruitment, joint stability, and overall functional movement [50]. The current findings are consistent with studies by Zeng et al (2021) which highlighted the critical role of muscle strengthening in improving knee joint function in patients with knee osteoarthritis [51]. Furthermore, the study showed a significant improvement in the ability to perform mechanical work, as evidenced by an increase in the mean score from 1.10 to 1.90 ($p = 0.00$, effect size = 23.86%). This improvement indicates that patients experienced improved functional ability, decreased discomfort associated with movement, and increased independence in performing daily activities [52]. The observed improvement in mechanical work ability could be attributed to a combination of reduced pain, increased muscle strength, and improved neuromuscular coordination. These findings are consistent with previous research by Alvani et al. (2021) and Wei, Guo, et al (2021) which confirmed that rehabilitation programs that include functional movement training and resistance training significantly improve quality of life and physical performance in patients with knee osteoarthritis [53,54]. Although the rehabilitation program was effective in managing pain and improving muscle strength and functional ability of the knee, the study did not observe any statistically significant change in the mobility index of the knee joint. The mean mobility index increased slightly from 179.00 to 180.00, but the p-value of 0.157 indicates that this change was not statistically significant. One possible explanation for this finding is that the baseline mobility index values were already within normal functional limits, limiting the extent of measurable improvement [55]. In addition, the rehabilitation program focused primarily on strengthening the quadriceps and reducing pain rather than directly targeting joint mobility and flexibility [56]. In contrast, previous studies such as Alamer, Abayneh, et al (2021) reported significant improvements in joint mobility after rehabilitation, likely due to the inclusion of flexibility training and joint mobilization techniques [57]. This discrepancy suggests that future rehabilitation programs should include dynamic stretching, proprioceptive training, and neuromuscular facilitation exercises to enhance joint mobility and range of motion in patients with knee osteoarthritis [58].

The significant improvement in pain management, muscle strength, and mechanical work capacity reinforces the need to incorporate structured exercise-based rehabilitation programs into standard treatment protocols for knee osteoarthritis in Saudi Arabia. Since knee osteoarthritis is a leading cause of disability among the elderly and women, implementing such rehabilitation programs nationwide could reduce healthcare costs associated with knee replacement surgeries and improve patient quality of life. Future research should focus on longitudinal studies with larger sample sizes to evaluate the effectiveness and long-term sustainability of rehabilitation interventions in the management of knee osteoarthritis.

Conclusion

The study provides strong evidence that the proposed rehabilitation program significantly improves pain management, quadriceps strength, and functional mobility in patients with knee OA. However, the lack of significant improvement in knee joint mobility index highlights the need for more comprehensive rehabilitation approaches that include joint mobilization and flexibility exercises. These findings emphasize the importance of individualized rehabilitation strategies that address both strength and mobility deficits to maximize outcomes for patients with knee OA. In addition, future research should explore the integration of multimodal rehabilitation techniques, such as aquatic therapy, proprioceptive training, and neuromuscular retraining, to improve functional recovery in patients with knee OA. Given the increasing burden of knee OA, the implementation of evidence-based rehabilitation programs in the Saudi Arabian healthcare system could play a critical role in promoting patient independence and reducing the long-term impact of OA-related disability.

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