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The Effect of Pilates Exercises on Knee Osteoarthritis

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Abstract:
Objective: To determine how Pilates exercise can help with knee osteoarthritis.
Methods: The study included 30 patients with intermediate chronic OA who were chosen at random from the outpatient clinic of Physical Therapy College. Their BMI was under 30 kg/m2, and their ages ranged from 40 to 65. They were split into two groups at random.

Study Group (A): For 8 weeks, a Pilates exercise programme consisting of three sessions per week was to be completed by 15 male patients with chronic knee (OA) who had been recommended by an orthopedist. Ultrasonic, infrared, and physical therapy exercises are also used as conversional therapeutic treatments, three times per week for eight weeks. 15 male patients with chronic knee (OA) diagnosed by an orthopedist were assigned to **the control group (B),** and they were given instructions to follow a 3-session/week traditional exercise programme, infrared therapy, and US application for 8 weeks. Before and after the program's eight weeks, researchers evaluated both groups' daily functional performance (WOMAC), knee joint range of motion (ROM), and pain level (VAS).

Results: After 8 weeks of treatment, both groups (A and B) demonstrated a substantial improvement (P0.05), a significant decrease in pain level (VAS), an increase in knee ROM, and a significant increase in functional daily activity (WOMAC). However, there was a clinical difference favoring group between the two after treatment in all measures (A).
Keywords: Pilates, WOMAC, VAS, Knee ROM, and chronic knee OA.

1.Introduction:

Osteoarthritis (OA) is a common, slowly progressing condition affecting the synovial joints. It's thought to be a chronic, progressive, degenerative disorder affecting the synovial joints. It is a common age associated locomotor illness of the developing countries which predominantly causes degeneration of hyaline cartilage, and its symptoms occur more often in the weight bearing joints of the lower extremities. The knee joints are the largest joints most frequently affected by this condition (14).

(OA) primarily affects the articular cartilage of the synovial joints, but it can also cause pathologic changes in the synovial fluid, the bone beneath the joint (subchondral bone), and the overlying joint capsule. On the articular surface of the injured cartilage, little tears known as fibrillations first form, then larger tears follow, and the cartilage eventually splits into joints (17).

Because of its physical limitations brought on by knee OA, which include discomfort, restricted joint motion, weak muscles, and impaired coordination, this condition has a severe impact on life quality (20).

The Pilates method connects physical exercise and mental well-being with a philosophy that is comparable to contemporary fitness ideas. During these prescribed workouts, quality motions are prioritized while keeping a neutral spine. Work on the

floor and on the apparatus are balanced to emphasize building strength and endurance. The difficulty of the floor exercises is increased by gravity, and a number of tiny aids have been created to complement these workouts (8).

The goal of the Pilates workout programme is to stretch and elongate all of the muscles. Pilates combines isometric workouts, ballet, and yoga. According to this approach, the body can be made more flexible, posture can be improved, the muscles can be strengthened without adding too much muscle, and stress levels can be decreased (18).

2. Materials and Methods:

2.1Subjects:

From July 2021 to April 2022, 30 patients with intermediate chronic OA were chosen at random from the Physical Therapy College outpatient clinic to participate in this study. Their BMI was under 30 kg/m2, and their ages ranged from 40 to 65. Any participant having a history of heart issues, hypertension, diabetes and history of previous knee surgery was excluded from this study.

Participants were split into two equal groups at random (A &B). Study Group (A): For 8 weeks, a Pilates exercise programme consisting of three sessions per week was to be completed by 15 male patients with chronic knee (OA) who had been recommended by an orthopedist. Ultrasonic, infrared, and physical therapy exercises are also used as conversional therapeutic treatments, three times per week for eight weeks. 15 male patients with chronic knee (OA) diagnosed by an orthopedist were assigned to the control group (B), and they were given instructions to follow a 3-session/week traditional exercise programme, infrared therapy, and US application for 8 weeks. The women were divided randomly into two groups by system of randomization. Eligible patients who were recruited on Saturday and Wednesday were assigned to the control group (A), and those on Sunday and Thursday were assigned to the study group (B). Both groups followed the same program of abdominal exercises; and only group (B) applied KT with the abdominal exercises. The groups received their treatment twice per week for 8 weeks. Every woman received a simple demonstration explaining the abdominal exercises and each one signed a consent to declare her agreement to take part during this study.

2.1. Evaluative procedures:

Before beginning the study, all patients in groups A and B received comprehensive study information and completed informed permission forms. Then, before and after the treatment course, each of them was evaluated in both groups A&B using the following methods:

2.1.1. Recording data sheet: The name, age, address, weight, and height of every patient who took part in this study were all recorded on the recording data sheet.

2.1.2. -Before the trial began, each patient in both groups (A&B) had their body mass index (BMI) calculated using a standard weight and height scale.

2.1.3 The VAS, which was used to gauge the severity of the pain.

2.1.4 Universal goniometer for measuring knee range of motion

2.1.5 The WOMAC scale (Arabic Version): It was used to evaluate how well patients with OA of the knee performed functionally. It has 24 criteria that describe the existence and intensity of pain throughout various daily activities.

2.1.2.1. .

2.2. Treatment procedures:

The two groups (A&B) received their treatments twice per week for 8 weeks.

2.2.1 Initial control group (A):

Each participant got standard care in the form of IR, US, and routine physical therapy exercises such as stretching the hamstring and calf muscles, straight leg lifting, and isometric quadriceps strengthening. For 8 weeks, there will be 3 sessions of 30 minutes each.

2.2.2 Study group (B):

Each participant got standard care in the form of IR, US, and routine physical therapy exercises such as stretching the hamstring and calf muscles, straight leg lifting, and isometric quadriceps strengthening. Pilates exercise routine for 20 minutes, three times per week for eight weeks, for a total of 30 minutes.

2.2.3 There are four groups in the Pilates workout programme:

2.2.3.1 Warm-up activities:

1. The patient was placed on his back with his knee bent and his feet flat on the ground. Then he instructed the participant to elevate his head and bend his hips 90 degrees, return to the starting position while taking a deep breath, and repeat.

2. Roll up exercise: The patient was instructed to lie on the mat with their arms and legs outstretched. Next, roll up to a sitting position with arms outstretched (C-Curve), then slowly return to the starting position while taking ten deep breaths.

3. One-legged circle: The patient was instructed to lie on his back with one leg straight up in the air and the other leg resting on the floor, both legs in the middle. Anchor your head, pelvis, shoulders, and arms to the mat. Then With your toe, make a circle. Circle up, down, and around while crossing a long leg over your

body. Roll your shoulder blades down, breathe deeply, and maintain your ribs on the mat for ten repetitions.

2.2.3.2 Exercises for the abdomen:

1. One single leg stretch exercise required the patient to lie on a mat with one knee bent toward his chest and hold it there with one hand for five seconds before relaxing and inhaling deeply. Ten times in a row.

2. The patient was instructed to extend his arms and lie on a mat with his legs straight. The patient was then instructed to stretch both of his arms and legs to a 45-degree angle. The patient was instructed to hold this position while taking a deep breath and repeat the exercise ten times.

3. Single straight leg stretch: The patient was instructed to lie on a mat with one straight leg, keeping their shoulders lightly pressed on the floor. Stretch the opposing leg out straight and just over the floor while holding one ankle or calf with both hands. Then, while taking a deep breath, return to the starting position. Ten times should be added.

4. A double straight leg lower lift, required the patient to place his fists under his hips for support. Standing straight up in the air with both legs joined in a soft Pilates position Maintain his lower back's contact with the ground. After that, unwind, take ten deep breaths, and repeat.

5. The cress cross exercise requires the patient to fold his hands behind his head with his elbows spread widely. The second leg stretched out far as the right knee bowed against your chest. Then, using the opposite elbow, attempt to get as close as you can to his knee. After that, take a big breath, relax, and repeat 10 times.

C) The spinal-stretching exercise category:

1. The patient was instructed to set up on a mat in a long sitting position with both legs wider than hip width and try to reach both of his legs with his straight arms. He was then instructed to keep the position while relaxing with a deep breath. 10 times were repeated.

2. Open leg rocker exercise: We requested the patient to lie on the mat with one flexed knee and hold it with both hands. Then, we asked him to try raising his extended knee upward with foot dorsiflexion, then relax with a deep breath. We asked him to do this exercise ten times for each leg.

3. The patient was instructed to lie on his back with his legs at a 90-degree angle as part of the crock screw exercise. In a light Pilates stance, secure your heels together. His palms, shoulder blades, ribs, and pelvis should be anchored to the mat.

4. The patient was instructed to perform the saw exercise by spreading his legs slightly wider than his shoulders and reaching his arms out to the sides in line with his shoulders. The patient was then instructed to twist his spine, lower his back arm to reach his foot with the opposite hand, relax with a deep breath, and repeat 10 times on the opposite side for each side.

- **Level (2):** Full side bridge, legs were extended, and the top foot was placed in front of the lower foot for support. This has been done on each side with hold.

2.2.3.3 Swan series workouts:

From 1. Swan prep-neck roll exercise: The patient was instructed to lie on his back with his hands under his shoulders and his elbows close to his ribs. He was then instructed to raise his upper body until both elbows were extended, relax with a deep breath, and repeat the exercise ten times.

2. single-leg kick exercise: the patient was instructed to lie on his back with both arms supporting him. He was then instructed to kick twice with one knee, relax with a deep breath for ten times, and repeat on the opposite side.

3. Rest posture exercise: the patient was instructed to sit on his heels with his legs together or slightly apart, extend his arms above his head, and take deep breaths through his nose. Pull your tummy away from your thighs as you exhale. Breathe in and out down your spine while you lean heavily on your thighs.

4. Shoulder Bridge exercise: The patient was instructed to lie on their back with their shoulders and hips pressed into the mat. With your feet parallel and your hips 12 inches apart from you, try to lift one hip, hold it, and then lower it again. Do this ten times.

2.2.3.4 Exercises from the Side Kick Series:

1. Front and back exercise required the patient to lie on a mat in a sideline position with his head resting on his hand and try to kick his leg upward with his extended knee to attain a 45-degree angle until he could lengthen his leg, at which point he was urged to relax with a deep breath. He requested that it be repeated 10 times for each leg.

2. The patient was instructed to maintain his side position and extend his top leg out to the front before returning to the starting position, taking a deep breath, and repeating the exercise 10 times for each.

3. Passé exercise: the patient was instructed to lie on a mat in the sideline position with his head resting on his hand and to try to kick his leg forward until he could stretch it, after which he was instructed to relax with a deep breath. He requested that it be repeated 10 times for each leg.

4. The patient was instructed to keep their leg extended and perform the circles exercise. Deeply scoop the abs Parallel legs. Take a normal breath. Equally wrap the leg around the front and the back. Reverse and lengthen while merely moving the leg.

5. Beats on belly transition exercise: the patient is asked to lie on his back with his palms towards the floor and his forehead resting on a stack of hands. Legs joined. Scoop your abs. Lift your relaxed legs off the

ground while clenching your butt, and then quickly beat your inner leg together while opening and closing your legs.

3. Results:

3.1. Subject characteristics:

The means ±SD of age and weight study group were (51.93±3.731) years and (91.64±6.709) Kg respectively. While for the control group, the means ±SD of age and weight were (51±3.658) years and (81.29±5.810) Kg respectively, By comparing both groups There was no statistically significant difference between both groups in the mean of age, weight and height (p > 0.05), **Table (1).**

Table 1. Show the Baseline physical characteristics of individuals completing the study (n= 30).

Characteristics	Control (A) (n=15)	Study (B) (n=15)	P value*
Age (yrs)	51.93 ± 3.731	51.93 ± 3.658	0.5025 NS
Weight (Kg)	91.64 ± 6.709	81.29 ± 5.810	0.7648 NS

NS P > 0.05 = non-significant, P = Probability.

3.2. VAS:

3.2.1 within groups:

The mean SD values of the pain level in the group during the "before" and "post" treatments were, according to **table (2),** 8.385.861 and 5.6071.15, respectively (A) There was a substantial reduction in pain following therapy compared to before treatment, according to multiple pairwise comparison tests (post hoc testing) (p-value = 0.00001). While the mean and standard deviation (SD) values of the pain level were 8.280.886 and 5.551.432, respectively, in the group (B), multiple pairwise comparison tests (post hoc tests) showed that the pain level significantly decreased after treatment (p-value = 0.0001) compared to before treatment.

3.2.2. Between groups:

Multiple pairwise comparison tests (post hoc tests) looking at the impact of the tested group (first independent variable) on pain level revealed that there were no significant changes in the mean pre-treatment values between the two groups (p=0.114). Additionally, numerous pairwise comparison tests showed that there was a significant difference in the means of the "post" treatments between the two groups with (p=0.0001) and that this difference was significantly in favor of group (B).

Table 2. Mean values of VAS pre and post treatment for the control and study groups (A&B).

	VAS			
Data of evaluation	**Group A (n= 15) (X` ± SD)**	**Group B (n= 15) (X` ± SD)**	**t value**	**p value**
Pre-study	8.385±.861	8.28±0.886	1.703	0.114
Post-study	5.607±1.15	5.55±1.432	0.302	0.0001
MD	2.78	2.73		
t value	6.099	3.73		
p value	0.001	0.0001		

3.3. ROM:

3.3.1 within groups:

In the group comparison shown in **table (3),** the mean SD values of the ROM in the "before" and "after" treatments were 81.466.19 and 91.466.69, respectively (A) There was a substantial increase in ROM after-treatment compared to pre-treatment, according to multiple pairwise comparison tests (post hoc testing) (p-value = 0.001). While the ROM's mean and standard deviation values were 73.156.12 and 83.158.12 in the group (B), respectively, multiple pairwise comparison tests (post hoc tests) showed a significant increase in the ROM at the post-treatment compared to the pre-treatment (p-value=0.0001).

3.3.2. Between groups:

Multiple pairwise comparison tests (post hoc tests) examining the influence of the tested group (first independent variable) on the BMI found no statistically significant differences between the mean values of the pre-treatment between the two groups (p=0.117). Additionally, numerous pairwise comparison tests showed that there was a significant difference in the means of the "post" treatments between the two groups with (p=0.0001) and that this difference was significantly in favor of group (B).

Table 3. Mean values of knee ROM pre and post treatment for the control and study groups (A&B)

	ROM			
Data of evaluation	**Group A (n= 15) (X` ± SD)**	**Group B (n= 15) (X` ± SD)**	**t value**	**P value**
Pre-study	81.46±6.19	73.15±6.12	2.133	0.017
Post-study	91.46±6.69	83.15±8.12	2.980	0.0007
MD	10	10		
t value	2.583	2.082		
p value	0.0001	0.0017		

NS P > 0.05 = non-significant, P = Probability

3.4. WOMAC :

3.5. 3.4.1 within groups:

The mean SD values of the functional performance level during the "before" and "post" treatment were, according to **table (4**), 87.0711.543, and 110.923'11.93, respectively, within group comparison (A). There was a substantial improvement in functional performance level after treatment compared to before treatment, according to multiple pairwise comparison tests (post hoc tests) (p-value = 0.001). While the group's mean and standard deviation (SD) values for the functional performance level were, respectively, 77.0711.543 and 100.9211.23 before and after the treatment (B). The body weight significantly decreased after therapy compared to before treatment, according to multiple pairwise comparison tests (post hoc tests) (p-value = 0.001).

3.4.2. Between groups:

Multiple pairwise comparison tests (post hoc tests) examining the impact of the tested group (first independent variable) on the functional performance level found no statistically significant differences between the mean values of the pre-treatment between the two groups (p=0.067). Additionally, repeated pairwise comparison tests showed that there was a significant difference in the means of the "post" treatments between the two groups with (p=0.004) and that this difference was much more in the group's favor (B).

Table 4. Mean values of body pain level using WOMAC scale pre and post treatment for the study and control groups (A&B)

	Knee function			
Data of evaluation	**Group A (n= 15) (X` ± SD)**	**Group B (n= 15) (X` ± SD)**	**t value**	**P value**
Pre-study	87.07 ±11.543	77.07 ±11.543	1.370	0.607
Post-study	110.923` ±11.93	100.92 ±11.23	1.970	0.0004
MD	23.84	23.87		
t value	4.744	3.212		
p value	0.001	0.004		
	VAS			
Data of evaluation	**Group A (n= 15) (X` ± SD)**	**Group B (n= 15) (X` ± SD)**	**t value**	**p value**
Pre-study	8.385 ±.861	8.28 ±0.886	1.703	0.114
Post-study	5.607 ±1.15	5.55 ±1.432	0.302	0.0001
MD	2.78	2.73		
t value	6.099	3.73		
p value	0.001	0.0001		

4. Discussion:

OA is one of the most common degenerative musculoskeletal disorders, characterized by a progressive loss of joint cartilage, synovial inflammation, formation of osteophytes, and subchondral bone remodeling,(OA) is the most common form of arthritis, affecting an estimated 302 million people worldwide , and is a leading cause of disability among older adults. The knees, hips, and hands are the most commonly affected appendicular joints (4).

Patients with OA are likely to be treated with a number of different pharmaceutical and non-pharmaceutical interventions, often in combination, Exercise is strongly recommended for all OA patients, there is considerably more evidence for the use of exercise in the treatment of knee(OA) and the variety of exercise options studied is far greater. While patients and providers seek recommendations on the “best” exercise and the ideal dosage (duration, intensity, and frequency) (16).

Pilates exercise program have been reported to be one of the non-pharmacologic approaches for managing knee osteoarthritis,

The study attempted to be objective with respect to the outcome measures as quantified active knee flexion range of motion that was measured by the universal goniometer. **Rothstein et al and Huang et al** demonstrated the validity and reliability of this instrument in the assessment of range of motion .The study used the Arabic version of WOMAC questionnaire shown in **(appendix V)**, its validity and reliability were tested by**(Guermazi et al).**In this study the pain level was measured by the Visual Analogue Scale. The validity and reliability of this instrument in the assessment of pain level have been demonstrated by **Dalton and McNaull.**

According to this results, Pilates exercise program was capable of reducing pain and improving knee functional performance for chronic (OA) patients with the same opinion of **Mazloum et al., (2018)** who had made a trial to detect the effect of conventional therapeutic exercises and Pilates on pain and function in patients with knee osteoarthritis. He found that both conventional therapeutic exercises and Pilates exercise program had a remarkable improvement on pain and function with a favor to the patient who participated in Pilates exercise program. Also, **Khan et al.,2018** reported that, A 2-week Pilates treatment intervention was more efficacious than conventional care in reducing pain intensity, functional disability levels, anxiety and depression but statistical difference was only in terms of NPRS due to small sample size and age variation in terms of accessible population. Pilates has many benefits that may affect Knee function such as

improving core strength, and increasing flexibility, circulation and balance

The results of our study had the same findings of **Akodu A. et al., 2017** study who showed that there were significant differences in the clinical outcome measures for Group that received TENS and Pilates exercises, the effect of Pilates exercises on pain showed that there was reduction in pain intensity, functional disability and increase in range of motion of the knee joint. In addition to **Yakut *et al*.** Who reported that Pilates exercises are an effective and a clinically practicable approach for patients with osteoarthritis of knee and it may be more effective when applied in group exercises. Similar study was conducted by **Linnea R., 2015**. It was a case study which suggested that Pilates has so many benefits for an osteoarthritic patient. In addition to the inherent benefits to all practitioners of Pilates, the OA patient will benefit particularly from the culture of non-competition and focus found in most studios.

The results of the control group (B) showed that there was a significant increase in functional performance level, increase in knee ROM, and decrease pain level for chronic knee OA.

Altas et al., 2020 study results also, showed that physical therapy modalities used in the treatment of knee OA had a positive effect on sleep quality. The modalities such as HP, US, TENS, and exercise were shown to be effective as evidenced by the improvements in the VAS, BDI, WOMAC, SF-36, ESS, and PQSI scores.

Also, **Herian et al., 2016** study reported that heat and US applications did not provide enough evidence for efficacy in reducing pain, whereas **Newberry et al., 2017** study found that therapeutic US was a beneficial and safe treatment modality for reducing pain and improving function in patients with knee OA. **Zeng et al.2014** also, demonstrated that pulsed US was beneficial in reducing pain and improving function in knee OA patients, whereas continuous US was only effective in reducing pain.

In an osteoarthritic joint, IL-1B induces the release of prostaglandins and nitrous oxide, which ultimately results in reduced proteoglycan synthesis and reduced extracellular cartilage matrix. Chowdhury and colleagues showed that dynamic compression of chondrocytes actually counteracts this release of prostaglandins and nitrous oxide.48 Thus, it is suggested that dynamic mechanical compression of the osteoarthritic knee joint may inhibit the inflammatory process. This compression could be mimicked during therapeutic exercise by performance of exercises that apply a dynamic, physiologic load to the knee joint. This could be achieved for those with knee OA with dynamic WB exercises.

Despite its countless scientifically proven beneficial effects, physical exercise in certain conditions could be detrimental to articular cartilage health. Studies on human subjects reported that even moderate exercise, recommended as a treatment for OA, might increase markers of cartilage degradation in OA-affected joints **Jayabalan et al (2019).** Observed that 45 min of continuous walking resulted in a cumulative increase in COMP concentration, a marker of cartilage turnover, whereas interval walking was associated with COMP concentrations comparable to baseline. This study shed light about the possibility that incorporating resting periods in walking regimens may impact the potentially deleterious effects of longer continuous walking bouts on the knee joint. **(Chowdhury et al., 2006).**

Accordingly, it can be concluded that pilates exercise can improve pain and functional ROM for chronic knee (OA) patient which consider the most important manifestations that affect their quality of life. The results of this study rejected the null hypotheses as there was significant difference between Pilates exercise and traditional therapeutic modalities. Both Pilates exercise and traditional therapeutic modalities were effective in reducing knee OA symptoms, but Pilates exercise was more effective.

5.Conclusion:

Based Within the limitation of this study, the following conclusion was warranted:

Pilates exercises can increase ROM in patients with chronic knee OA. Pilates exercises can improve Pain intensity in patients with chronic knee OA. The effect of Pilates exercises on performance level in patients with chronic knee OA is greater than using traditional therapeutic modalities.

Conflict of Interests:

The authors declare no conflict of interest.

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