ISSN: 1607-8322, e-ISSN: 2220-5799 **Anaesthesia, Pain & Intensive Care**
Vol 26(3); June 2022 DOI: 10.35975/apic.v26i3.1894

ORIGINAL RESEARCH **PAIN MANAGEMENT**

Effect of Pilates based exercises for improving pain and physical function in symptomatic knee osteoarthritis –a randomized controlled clinical trial

Nadia Saleem, MSOMPT, BSPT [1], Iqra Waseem, MSMSK, DPT [2], Farwah Batool, MSPTM, DPT, [3] Tahir Mahmood, MSPTM, DPT [4], Wajeeha Mahmood, MSNMPT, PPDPT, BSPT [5]

Author affiliation:

1. Nadia Saleem, Assistant Professor/Consultant PT, Abdul Waheed Institute of Allied Health Sciences, Aveccina Medical and Dental College, Lahore, Pakistan**;** E-mail: nadiasaleem256@gmail.com
2. Iqra Waseem, ORCID {0000-0002-1487-7749} Assistant professor, University Institute of Physical Therapy, The University of Lahore, 1-Km Defence Road, Lahore, Pakistan**;** E-mail: iqra.waseem91@gmail.com
3. Farwah Batool, Lecturer, Aqsa Institute of Professional Studies, Sheikhupura - Faisalabad Road, Sitara Valley, Faisalabad, Pakistan**;** E-mail: farwahbatool6gmail.com
4. Tahir Mahmood, ORCID {0000-0003-0175-5248}Senior Lecturer /Physical Therapist, Department of Physical Therapy, Imran Idrees Institute of Rehabilitation Sciences, Sialkot Medical College, Daska Road, Sialkot, Pakistan 51040; E-mail: tahirmahmoodphysio@gmail.com
5. Wajeeha Mahmood, ORCID {0000-0001-9578-583X} Assistant Professor, Department of Physical therapy, faculty of Allied Health Sciences, Superior University Lahore, Pakistan; E-mail: higheraimz@gmail.com

Correspondence: Iqra Waseem, MSMSK, DPT, ORCID {0000-0002-1487-7749}; E-mail: iqra.waseem91@gmail.com; Phone: +92334777939

Abstract

Background and Objective: Osteoarthritis (OA) a common wear and tear pathology of joints occurring among females. There is need of exercises regimen is known to be the most appropriate conventional treatment that stop the progression of degeneration. Pilates based exercises are recommended for reduction of the pain and strengthen the peripheral muscles. The Objective was to determine the effects of Pilates based exercises on pain and physical function in women with knee OA.

Methodology: This randomized clinical trial was conducted on 40 female patients with knee OA grade II and III, selected randomly and divided into two groups. After baseline evaluation using WOMAC scale, both groups received interventions for 8 weeks, 3 times per week and each session lasting for an hour. Statistical analysis using analysis of variance and independent sample t test significance at $p < 0.1$ were used.

Results: In the study, 20 females in each group with mean age in Pilates group 57.60 ± 6.34 and in isometrics group was 55.65 ± 7.28. The results showed that both groups differed significantly over the time period of 8 weeks and showed significant improvement for pain and physical function; $p < 0.1$. When comparing Pilates with isometrics, patients in Pilates group showed significantly better improvement in terms of pain and physical function; $p < 0.1$.

Conclusion: Pilates based exercises had significant effects in improving physical function and reduction of pain with statistically significant difference compared to Isometric exercises in symptomatic knee OA.
Trial Registration Number: Chi CTR 2000030486

Abbreviations: OA – Osteoarthritis; WOMAC - Western Ontario & McMaster University Osteoarthritis Index; ROM - range of motion; QoL - quality of life; PBE - Pilates based exercises

Key Words: Exercise; Isometrics; Knee osteoarthritis; Pilates; Pain; Physical Functions; WOMAC

Citation: Saleem N, Waseem I, Batool F, Mahmood T, Mahmood W. Effect of Pilates based exercises on symptomatic knee osteoarthritis for improving pain and physical function –a randomized controlled clinical trial. Anaesth. pain intensive care 2022;26(3):291-296. **DOI:** 10.35975/apic.v26i3.1894

Received: November 21, 2021, **Reviewed:** February 8, 2022, **Accepted:** March 7, 2022

1. Introduction

Osteoarthritis (OA) is generally classified into two main groups including a primary mainly idiopathic or non-traumatic, another one is secondary usually due to trauma or mechanical misalignment. However, OA is a degenerative disease of cartilage but evidence has proven that OA is caused by multiple factors including trauma, mechanical forces and metabolic derangements.[1] OA of the knee is associated with torment, swelling, diminished range of motion (ROM), unsteadiness, anatomical distortion in serious cases, diminished useful movement, and decreased personal satisfaction etc. Ageing of people and increasing sedentary lifestyles leading to obesity, are the main factors leading to the development of OA and related impairment of the knee joint. Obesity is known as another causative factor, being more typical among the females.[2] These patients have decreased functioning index which affect their quality of life (QoL). Physical function can be improved by different conventional techniques, including biomechanical lateral wedge, and are effective in reduction of pain and improving QOL.[3] A systematic review stated that, Pilates and aerobics for 8-12 weeks, 3-5 sessions per week was effective regarding pain and strength improvement.[4] Pilates are being widely used now a days for physical wellness

framework, created in the mid twentieth century by Joseph Pilates after whom it was named.[5] If done on a regular basis and with consistency, Pilates enhances adaptability, quality and motion control and perseverance in the whole body.[6] The Pilates strategy is an extensive body-molding technique, that is coordinated towards the improvement of both the body and the brain re-education.[7] The center, comprising of the muscles of the midriff, low back, and hips, is frequently called as "control house" and is known as the only successor for the stability of the patient.[8] The beneficial effect of Pilates is by decreasing major risks and indirectly involved in improving compromised functions among subjects with OA of knee.[9] But in Pakistan the prevalence has been high compared to other countries, with 25 - 28% (rural –non- urban) and age more than 50 y, occupational overuse of knee and obesity were common reported risk factors in Pakistan.[10] In Pakistan, the incidence is found to be 29.7-37.0/1000 according to a recent study.[11] A highly prevalent condition among younger adults which needs interventional strategies including training, coping, weight reduction and use of medications.[12]

The aim of physiotherapy in management of OA is to control the debilitating pain arising from knee joint and to improve function and QoL. Thus, non-pharmacological treatment should be considered as

first-line treatment for knee OA. Various non-surgical treatments have been tried and studied for their effectiveness. Both Pilates based exercises (PBE) and isometric exercises are being used for treatment of knee OA and have shown their effectiveness. This study will help us to find which technique is better in management of symptoms due to knee OA and reduction in pain and physical functioning among patients with knee OA. We compared the effectiveness of PBEs and knee isometric exercises on pain, physical functions in patients with knee OA.

2. Methodology

This study was a double-blind, randomized clinical trial, conducted after approval from Ethical Review Committee, (Ref # RCR&AHS/REC/MS-OMPT/S18/022) from April 2018 to October 2018 at National Orthopedic Hospital, Bahawalpur. The sample size was calculated by using post-treatment mean physical QoL scores of patients with knee OA by 52.49 ± 11.13 for isometrics group and 49.77 ± 17.95 for Pilates group, based on an earlier study,[13] which gave an effect size of 0.821. Level of significance was kept 0.1 and power of the study was 0.9. Sample size was calculated using G'Power version 3.1.9.2 which gave a sample size of 40, with 20 participants in each group. The study was conducted according to CONSORT. Non-probability convenient sampling technique was used.

We included females with pre-diagnosed Grade II or III knee OA, based on Kellen & Lawrence classification for knee OA having unilateral or bilateral knee arthritis in age range of 35-65 y. The females with past knee surgery e.g. total knee replacement (TKR), intra articular steroid injection within the past 6 months, use of assistive devices, cardio-respiratory dysfunction and any neurological condition affecting lower limbs and the balance, were excluded. The patients were randomly

Table 1: Patient data (Mean ± SD)

Patients data	Pilates Group	Isometrics Group
Age (y)	57.60 ± 6.34	55.65 ± 7.28
Height (m)	1.61 ± 0.054	1.62 ± 0.05
Weight of the participant (kg)	66.53 ± 10.65	70.04 ± 10.09
Body Mass Index (kg/m^2)	25.81 ± 4.16	26.93 ± 4.28

Table 2: Pretreatment comparison of characteristics of both groups (Mean ± SD)

Basic details	Pilates	Isometrics	P-value
Age	57.60 ± 6.34	55.65 ± 7.28	0.37
Body Mass Index	25.81 ± 4.16	26.93 ± 4.28	0.40
WOMAC Pain Score at Baseline	16.10 ± 0.91	16.65 ± 1.30	0.13
WOMAC Physical Function at Baseline	53.25 ± 3.99	54.15 ± 4.40	0.50

Table 3: Within the group's comparison pain and physical function

WOMAC	Evaluation	Pilates	Isometric	P-Value
WOMAC- Pain	At Baseline	16.10 ± 0.91	16.65 ± 1.30	.00
	After 4 weeks	14.45 ± 0.94	16.00 ± 0.79	
	After 8 weeks	12.65 ± 1.38	14.05 ± 0.99	
WOMAC- Physical Function	At Baseline	53.25 ± 3.99	54.15 ± 4.40	.00
	After 4 weeks	43.80 ± 8.16	47.80 ± 6.566	
	After 8 weeks	40.60 ± 7.829	47.80 ± 6.566	

allocated to one of the two groups, i.e. experimental group (Pilates group) and control group (isometrics group) by the

computerized random number generator (random.org).[14] Signed consent was obtained from all of the participants. They were then briefed about the study and its objective. Data was collected from each of the participants at baseline level and an administrative assistant allocated interventions via opaque sealed envelope marked according to the allocation schedule. Before randomization, an assessor performed the subjective (pain and function) examination. Four of the 44 patients who were included in this study were lost to the follow ups; thus 40 patients completed the study. In control group (isometrics) protocol included hot pack treatment for 7-10 min, TENS for 10 min, followed by quadriceps strengthening and hamstring stretching exercises, 2 sessions/week were performed for 8 weeks. In experimental group (Pilates**),** protocol included hot pack treatment for 7-10 min, TENS for 10 min, followed by PBEs for 8 weeks with 2 sessions/week for 8 weeks were given. The duration of Pilates was one hour (10 min as warm up, 40 min of Pilates exercise and 10 min as cooling).

The Pilates exercise protocol contained postural training, relaxation, stretching, balance, breath and strength training. The quadriceps and gluteus strengthening exercises, bridging, squats with ball, lateral band walk, stretches to improve flexibility for hip flexor, gluteus, seated hamstring, quads stretch and for control, single leg squat was given. The participants were given 100 in 5 repetitions and 2 sets in week 1 and one leg stretch and double leg stretch with 6 repetitions and 2 sets in 2nd and 3rd week. In 4th week addition of 7

repetitions of clams was made. In week 5,6 further addition of 2 sets of one leg kick and in week 7 patients additionally performed 8 repetitions of sidekicks. In week 8 addition of 10 repetitions of one leg circle was made.[15] A semi-structured questionnaire was used to measure functional outcome and Western Ontario & McMaster University OA Index (WOMAC) to assess functional ability of OA patients and reassessment was done at the end of 4th and 8th week. Ethical and moral values were considered during the study. No harm was made to the patient and their confidentiality was strictly maintained. Data was analyzed through SPSS 23 (Statistical Package for the Social Sciences). Shapiro Wilk's test was used for normality of data. After fulfilling parametric assumptions, repeated measurement ANOVA was used for within the group analysis and independent sample T- test was used for between the groups comparison. $P \leq 0.01$ was considered as significant.

3. Results

A total of 44 patients were recruited in the study out which 4 patients dropped out due to personal reasons. Out of 40, 6 (15%) had bilateral knee OA and 34 (85%) had unilateral disease. A pretreatment independent sample t-test analysis at base line, showed no significant difference between age (0.372), BMI (0.407), WOMAC pain score (0.131) and physical function score (0.503). Patient data is given in Table 1 and 2.

The WOMAC-Pain score was 15.35 ± 0.98 at baseline, after 8 weeks sessions it was decreased to 12.65 ± 1.38,

Table 4: Between the groups comparison for pain and physical function

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		f.	Sig.	t	Df.	Sig. (2-tailed	Mean Difference	Std. Error Difference	90% Confidence Interval of the Difference	
									Lower	Upper
Pain Score at Baseline	Equal variances assumed	2.11	.154	**-7.37**	38	.00	-2.05	.27	-2.51	-1.58
	Equal variances not assumed			-7.37	35.52	.00	-2.05	.27	-2.51	-1.58
Pain Score after 8 Weeks	Equal variances assumed	3.64	.064	-3.66	38	.00	-1.40	.38	-2.04	-.75
	Equal variances not assumed			-3.66	34.52	.00	-1.40	.38	-2.04	-.75
Physical Function At Baseline	Equal variances assumed	1.80	.187	-.67	38	.50	-.90	1.33	-3.14	1.34
	Equal variances not assumed			-.67	37.65	.50	-.90	1.33	-3.14	1.34
Physical Function after 8 Weeks	Equal variances assumed	4.43	.042	-3.15	38	.00	-7.20	2.28	-11.05	-3.34
	Equal variances not assumed			-3.15	36.88	.00	-7.20	2.28	-11.05	-3.34

as compared to isometrics group, in which it was 17.40 ± 0.75 at baseline, and decreased to 14.05 ± 0.99 after 8 week sessions (Table 3).

Results of the independent t test between the group analysis showed that Pilates group and isometrics group differed significantly in terms of increase in mean physical function at WOMAC- physical function which

was 12.65 ± 1.38 and 14.05 ± .99 respectively after 8th week of treatment; (P = 0.001) as shown in Table 4.

4. Discussion

This study confirmed that PBE regime can improve pain and physical functional outcomes. The impact of a PBE program for knee OA has been recommended to be used as a sheltered and powerful remedial technique to enhance capacity and personal satisfaction in knee OA.[6] Same effect was observed in our study as PBEs significantly improved patient pain and reduced physical index over a time period of 8 weeks.[16, 17]

The physical function can be improved using PBE in knee OA, comparing it with biomechanical technique called "lateral wedge" for improving pain and QoL.[18] Despite of specified targeted assessment was not part of our study, but an increase in knee function with improvement in flexion range of motion was observed, proving that PBEs improved quadriceps and hamstring strength directly affecting the ROM positively. Besides, it appears that a positive change in the general condition in the patients may bring about improved scores in torment and handicap.[19] The PBEs might cause an increase in stimulation of mechanical receptors and overcome the neuromuscular defense mechanism that facilitates the movements.[20]

In the current study, patients in PBEs had decreased pain and improved function scores with significant difference between the two techniques; although both interventions

improve function by increasing circulation in both groups. The use of quadriceps strengthening exercise was thought to improve pain and disability, which can improve function that is caused by increasing the blood flow.[21]

The PBE might cause an increase in stimulation of the mechanical receptors and overcome the neuromuscular defense mechanisms, thus facilitating the movements.[22] Both interventions improve function because exercise can increase circulation, which has beneficial effects, but the pain and physical function was significantly improved with PBE than isometric exercise in patients with Knee OA.[23] The quadriceps, hamstrings, calf, and ankle exercises can lead to an increased blood flow, thus reducing pain, which can improve function.[24] In contrast, a systematic review stated that exercise in combination with electrotherapy has superior effects compared to exercise alone for reduction in pain and improving functions in Knee OA.[25] Further, combining with stretching exercise can have positive effects if the surrounding tissues have restricted movements, serving as a facilitator of inhibited muscles.[13,26] Patients reported a decreased fear of falls and decreased difficulty in performing different functions, which shows the importance of the PBE program. The effects of Pilates on knee OA shall provide a better insight into the subject, and warrants some long-term studies. The results can be compared to the use of lateral insoles, which are supposed to change the biomechanical stress on the involved knee.

5. Limitations

The small sample size and lack of long term follow up to investigate the long term effects of the two therapeutic interventions have been the main limitations of our study. We included only female participants in the study. We recommend that PBE should be used in clinical practice because of the ease of usage, cost–effectiveness and the potential benefits by making it accessible at all healthcare institutions.

6. Conclusion

We conclude that Pilates based exercises are effective in management of knee osteoarthritis for pain and physical function improvement compared to isometric exercises in the management of symptomatic knee OA.

7. Acknowledgements

We are thankful to Prof. Dr. Tahseen Cheema, Dr. Javed Khan and Dr. Tariq Malik (PT) for their support in data collection.

8. Disclosure/Conflict of Interest

None declared by the authors.

9. Financial Disclosures

No institutional or industry funding was involved in the study.

10. Data availability

The numerical data related to this study is available with the authors and can be provided on suitable request.

11. Authors' contribution

NS: Conception and design, collection and assembly of data:

IW: Analysis and interpretation of the data and drafting of the article, collection and assembly of data, final approval and guarantor of the article

FB: Analysis and interpretation of the data and critical revision of the article for important intellectual content, statistical expertise

TM: Literature search, assembly of data, drafting of the article:

WM: Critical revision of the article for important intellectual content: statistical expertise

12. References

1. Mora JC, Przkora R, Cruz-Almeida Y. Knee osteoarthritis: pathophysiology and current treatment modalities. J Pain Res. 2018 Oct 5;11:2189-2196. [PubMed] DOI: 10.2147/JPR.S154002
2. Vieira ND, Testa D, Ruas PC, Salvini TF, Catai AM, de Melo RC. The effects of 12 weeks Pilates-inspired exercise training on functional performance in older women: A randomized clinical trial. J Bodyw Mov Ther. 2017 Apr;21(2):251-258. [PubMed] DOI: 10.1016/j.jbmt.2016.06.010
3. Muhammad A, Azam MJ, Salam A. Impact on quality of life in patients with knee osteaoarthritis in Faisalabad. J Uni Med Dent Col. 2018;9(3):49-52. [FreeFullText]
4. Raposo F, Ramos M, Lúcia Cruz A. Effects of exercise on knee osteoarthritis: A systematic review. Musculoskeletal Care. 2021 Dec;19(4):399-435 [PubMed] DOI: 10.1002/msc.1538
5. Bernardo LM. The effectiveness of Pilates training in healthy adults: An appraisal of the research literature. J Bodyw Mov Ther. 2007;11(2):106-10. DOI: 10.1016/j.jbmt.2006.08.006
6. Altan L, Korkmaz N, Dizdar M, Yurtkuran M. Effect of Pilates training on people with ankylosing spondylitis. Rheumatol Int. 2012 Jul;32(7):2093-9. [PubMed] DOI: 10.1007/s00296-011-1932-9
7. Bird ML, Fell J. Positive long-term effects of Pilates exercise on the aged-related decline in balance and strength in older, community-dwelling men and women. J Aging Phys Act. 2014 Jul;22(3):342-7. [PubMed] DOI: 10.1123/japa.2013-0006
8. Bird M-L, Hill KD, Fell JW. A randomized controlled study investigating static and dynamic balance in older adults after training with Pilates. Archives of physical medicine and rehabilitation. 2012;93(1):43-9. [PubMed] DOI: 10.1016/j.apmr.2011.08.005

9. Pilates JH, Miller WJ, Robbins J, Van Heuit-Robbins L. Pilates' return to life through contrology. In: Presentation dynamics; 1998.
10. Sheikh NI, Tahir F, Zahoor A. Risk factors for osteoarthritis of knee joint among Pakistani population. J HBS. 2021;1(2):66-8. [FreeFullText]
11. Khan RM, Albutt K, Qureshi MA, Ansari Z, Drevin G, Mukhopadhyay S, et al. Time-driven activity-based costing of total knee replacements in Karachi, Pakistan. BMJ Open. 2019 May 28;9(5):e025258. [PubMed] DOI: 10.1136/bmjopen-2018-025258
12. Sharma L. Osteoarthritis of the knee. N Engl J Med. 2021;384(1):51-9. [PubMed] DOI: 10.1056/NEJMcp1903768
13. Mahmood T, Hafeez M, Ghauri MW, Salam A. Instrument assisted soft tissue mobilization-an emerging trend for soft tissue dysfunction. J Pak Med Assoc . 2021 Mar;71(3):977-981. [PubMed] doi: 10.47391/JPMA.1168.
14. Raposo F, Ramos M, Lúcia Cruz A. Effects of exercise on knee osteoarthritis: A systematic review. Musculoskeletal Care. 2021 Dec;19(4):399-435.doi: 10.1002/msc.1538.
15. Najafabadi MT, Mahdavinejad R, ali Ghasemi G. Comparison of isometric and Pilates exercises on Knee pain and quality of life in women with Knee Osteoarthritis. Asian J Multidisciplinary Stud. 2014;2(3):109-112. [FreeFullText]
16. Mads Haahr. RANDOM.ORG; 2018 Available from: https://www.random.org/company/
17. Baltaci G, Tunay V, Duzgun I, Ozer Kaya D, Yakut E. 523 Comparison of strength, functional outcome and proprioceptive ability after pilates-based exercise program in women patients with knee osteoarthritis and healthy women. Oseteoarthritis Cartilage. 2008;16(Suppl 4):S223. DOI: 10.1016/S1063-4584(08)60562-2
18. Johnson EG, Larsen A, Ozawa H, Wilson CA, Kennedy KL. The effects of Pilates-based exercise on dynamic balance in healthy adults. J Bodyw Mov Ther. 2007;11(3):238-42. DOI: 0.1016/j.jbmt.2006.08.008
19. Cancela JM, Oliveira IM, Rodríguez-Fuentes G. Effects of Pilates method in physical fitness on older adults. A systematic review. Eur Rev Aging Phys. 2014;11:81–94. DOI: 10.1007/s11556-014-0143-2
20. Salam A AM, Mahmood T, Rukh MS, Seffat N. Application of lateral wedge in knee osteoarthritis for improving pain and quality of life. J Liaquat Uni Med Health Sci. 2019;18(02):146-51. [FreeFullText]
21. Ettinger WH, Davis MA, Neuhaus JM, Mallon KP. Long-term physical functioning in persons with knee osteoarthritis from NHANES. I: Effects of comorbid medical conditions. J Clin Epidemiol. 1994 Jul;47(7):809-15. [PubMed] DOI: 10.1016/0895-4356(94)90178-3
22. La Touche R, Escalante K, Linares MT. Treating non-specific chronic low back pain through the Pilates Method. J Bodyw Mov Ther. 2008 Oct;12(4):364-70. [PubMed] DOI: 10.1016/j.jbmt.2007.11.004
23. Shakeel R, Khan AA, Ayyub A, Masood Z. Impact of strengthening exercises with and without blood flow restriction on quadriceps of knee osteoarthritis patients. J Pak Med Assoc. 2021 Sep;71(9):2173-2176. [PubMed] DOI: 10.47391/JPMA.377
24. La Touche R, Escalante K, Linares MT. Treating non-specific chronic low back pain through the Pilates Method. Bodyw Mov Ther. 2008 Oct;12(4):364-70. [PubMed] DOI: 10.1016/j.jbmt.2007.11.004
25. Saleem N, ahid S, Mahmood T, Ahmed N, Maqsood U,

    Chaudhary MA. Effect of Pilates based exercises on symptomatic knee osteoarthritis: A Randomized Controlled Trial. J Pak Med Assoc. 2022 Jan;72(1):8-12. doi: 10.47391/JPMA.495
26. Salam A, Awan WA, Khalid A, Mahmood T, Ghauri MW. Effectiveness of Lateral Insoles in Improving Activity of Daily Living Among Patients of Knee Osteoarthritis. J Riphah Coll. Rehabili. sci. [Internet]. 2021Dec.16 [cited 2022Jun.29];9(2). Available from: https://journals.riphah.edu.pk/index.php/jrcrs/article/view/692

