International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Effectiveness of Pilates Exercises versus Closed Kinematic Chain Exercises in Knee Osteoarthritis Post - Menopausal Women - An Experimental Study

Dr Kajal Girdharlal Chauhan

Assistant Professor, Sharda college of Physiotherapy. A'bad
Email ID: *Kajal.chauhan.acp[at]gmail.com*
Contact No: 8469263778

Abstract: ***Osteoarthritis is the most common disease of women after menopause. There are many factors to develop the disease. The incidence of osteoarthritis (OA) increases after menopause. Recently Pilates exercises and Closed Kinematic Chain exercises have drawn much attention in the management of Knee Osteoarthritis. Pilates exercises may effect in increasing neurological coordination, improve recruitment of muscle fiber, stimulation of proprioception in the knee joint. Closed Kinematic Chain exercises have been argued to be more functional as it stimulates the role of lower limb muscles in daily activities. Method: Experimental study was done for 6 weeks includes Pilates Exercises and Closed Kinematic Chain Exercise with 45 subjects (15 subjects in each group) with Convenience sampling in Hospital, Ahmedabad.6 weeks of training programme was given which includes Pilates Exercises and Closed Kinematic Chain Exercises. Pain intensity (PPT), Range of motion (Knee Flexion and Extension) and Quality of life (SF36) were taken as outcome measures. Results: Result was statistically significant in all outcome measures PPT (<0.001, Quality of life (<0.001) ROM (<0.003), WOMAC (<0.004) respectively. In this study, Pilates and Closed Kinematic Chain exercises have showed statistically significant difference within the groups in Reducing Pain, Improving ROM & Functional performance and quality of life in subjects with Knee Osteoarthritis. Control group has shown statistically significant result but with comparison is it less effective. Pilates, close kinematic chain and control group respectively has shown better results. Conclusion: Pilates is more effective compare to close kinematic chain and control group. Pilates should be given importance to improve functional ability in post menopausal osteoarthritis females.***

Keywords: Pilates, Close Kinematic Chain Exercise, Osteoarthritis, WOMAC, PPT

1. Introduction

The knee is one of the most mechanically vulnerable areas in the body due to force and leverage acting on the joint both in terms of acute traumatic impacts and also in terms of weight bearing. [1] Knee osteoarthritis is the most common disease of the knee joint and a growing public health problem with physical disability, preventing performance of daily activities [1].

Pain and disability are also major problems in patients with knee osteoarthritis; these lead to decreased physical functioning, and greater difficulty performing their activities of daily living, resulting in a decline in health related quality of life [2]. Prevalence of OA is higher in women than in men, and incidence rises with ageing [2]. Incidence of this common progressive joint disease rises faster in women than in men after the age of 50 years; around the same age of the climacteric transition in women [2]. Osteoarthritis is a common disease of age, population and oneof the leading causes of disability [3]. Osteoarthritis affects all the structures of the joint. [3].

Osteoarthritis is the most common type of arthritis; it not only causes loss of articular cartilage, but also causes capsular stretching, ligament laxity, bony remodeling and weakening of muscles [3, 4]. Pain and other symptoms of OA have adverse effect on quality of life affecting both physical function and psychological parametersin post menopausalfemales. [3, 5]. Radiological features include joint space narrowing, osteophytes formation and subchondral sclerosis [3, 6]. Pain, in knee OA increases by activity and relieves by rest. [6]. Impairments such as Pain with mechanical stress or excessive activity, Pain at rest in the advanced stages, Stiffness after inactivity, Limitation of motion, Muscle weakness, Decreased proprioception and balance causes Functional limitations in ADLs and IADL [7]. Post menopausal woman gets calcium deficiency so joint is not getting nutrition, due to that degeneration starts. Treatment options are available for osteoarthritis of knee such as patient instruction, pain management, maintenance of the stage and improve functioning are major goals [7]. Resisted exercise, Mobilization, Stretching, Gait and posture correction, Modalities, Balance activates, Proprioceptive training, Aerobic conditioning, Dry needling, Cupping therapy, Acupressure, Taping, External support are various interventions [7].

Pilate's exercises were designed by Joseph Pilates in Germany in 1883. It is a mind - body fitness program. Pilates exercise are constructed in order to develop a strong core, create a balance of strength and flexibility, train efficient movement patterns, create a long and lean appearance and concentrate on the mind - body connection [3, 8]

Closed Kinetic Chain (CKC) exercises or closed chain exercises are exercises or movements where the distal aspect

of the extremity is fixed to an object that is stationary. With the distal part fixed, movement at any one joint in the kinetic chain requires motion as well at the other joints in the kinetic chain, therefore, both proximal and distal parts receive resistance training at the same time. [9] CKC exercises have gained popularity over Open Kinetic Chain (OKC) exercises because many therapists believe that CKC exercises are more reliable and functional. [10] Uçar et al. affirmed that for rehabilitation post ACL reconstruction, CKC exercises were more effective than OKC exercises at regaining mobility and enabling a quicker return to daily and sporting activities. [11]. Closed kinetic chain exercises stimulate the proprioceptive system by proprioceptive feedback to initiate and control muscle activation patterns. [12]

Menakshi (2021) et al concluded that six weeks of Interventions of Pilates exercises and Closed Kinematc Chain exercises were shown statistically improvement on Reducing Pain, Improving Muscle strength and Functional performance. However more Percentage of improvement was found in subjects received Pilates exercises when compared to Closed Kinematc Chain exercises. [13]

Aims ad Objectives

To compare effects of Pilates exercises and closed kinematic chain exercises on pain, and functional performance in post menopausal knee osteoarthritis females

2. Materials and Methods

An experimental study with Convenience sampling method on 45 females (15 in each group) with prior consent in hospital, Ahmedabad.6 weeks of training programme was given which includes Pilates Exercises and Closed Kinematic Chain Exercises. Recruited participants were explained the purpose and relevance of the study. After obtaining informed consent willing participants included in the study. Participant's age, weight, height, and body mass index were determined. All the eligible Participants were consecutively divided to Pilates Exercises Group (Group A), Closed Kinematic Chain Exercises Group (Group B) and control group (Group C) with 15 in each group

Selection Criteria [14]

Inclusion Criteria

- Knee Osteoarthritis having symptoms of pain and at least 3 features of the following items according to American College of Rheumatology (ACR) criteria;
- Post menauposal females
- Able to ascend and descend stairs,
- Unilateral Osteoarthritis of Knee, Grade 1 and Grade 2 Osteoarthritis of Knee (Kellgren& Lawrence)
- BMI (moderate),
- Pain and limitation of ROM, Tenderness,
- Early morning stiffness about 30 min.

Exclusion Criteria

- Traumatic injury to knee, Neurological diseases,
- Limb length discrepancy,
- Any intra articular injection to the knee,
- Any history of Hip, Knee,
- Ankle injury, Surgery prior to the study, Any local systemic infection,
- Subjects in regular Medications/Intra articular injections,
- Fixed deformity in limb

Intervention [14, 15, 16, 17]:

Group A. Pilates exercise (4 days a week) [16, 17]	Group B. Close kinematic chain exercise (4days a week) [14, 15]	Group C. control group [16, 17]
Week 1, 2 Hundreds (5 repetitions) One leg stretch (3 repetitions) Double leg stretch (3 repetitions)	**Week 1 (2 sets, 10 repetition each, 10 RM)** Quadriceps setting Wall slides **Week 2 - 3 same with new RM**	**Week 1, 2** Hot water fomentation for 10 minutes. Static quadriceps exercise, straight leg raising exercise, last degree extension, hip muscle strengthening Ultrasonic therapy for pain relief
Week 3, 4 Add in previous intervention Clams (7 repetitions) One leg kick (7 repetitions) **Week 5, 6** Add in previous intervention One leg kick (7 repetitions) Side kick (8 repetitions) One leg circle (10 repetitions)	**Week 4 (3 sets, 10 repetition each, 10 RM)** Quadriceps setting Wall slides with weight (dumbbell) Step up down (low stool) Terminal extension with Theraband **Week 5 - 6 with new RM**	**Week 3, 4** Strengthening in progress Hot water fomentation for 10 minutes Week 5 - 6 continue same with progress in RM

3. Outcomes Measures:

[1] PRESSURE PAIN THRESOLD (PPT) [18]

Pain pressure threshold (PPT) is used to measure deep muscular tissue sensitivity. The test determines the amount of pressure over a given area in which a steadily increasing non - painful pressure stimulus turns into a painful pressure sensation. A varying pressure is applied from 0.5 to 1 kg/sec in a perpendicular direction relative to the muscle. PPT has no standard protocol on administration and placement. Equipment used varies with many handheld electric algometers

[2] Knee flexion and Extension range of motion: [19]

Range of motion is taken by Goniometer. Patient is in supine lying. Goniometer is kept on lateral side of the leg. Fulcrum

on lateral epicondyle of femus. Stable arm is parallel midline to lateral aspect of femur and movable arm is kept on parallel midline of lateral aspect of tibia. With proper stabilization range of motion is measured.

[2] WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index [20]

This Questionnaire is used to assess the health status of Osteoarthritis patient introduced in 1988. It is consisted of 33 items which evaluates the health and function of the patient from various aspects including: Clinical symptoms (5 questions), Severity of joint stiffness ((2 questions), Degree of pain (9 questions) and Activity of daily living (17 questions). Each question has five subscales where best situation score as never or none and the worst one names as extreme or always. Here higher scores are representative of better situation and less pain

[3] SF 36 QUALITY OF LIFE - [21, 22]

The 36 - Item Short Form Survey (SF - 36) is an oft - used, well - researched, self - reported measure of health. It stems from a study called the Medical Outcomes Study [21]. It comprises 36 questions which cover eight domains of health. Limitations in physical activities because of health problems, Limitations in social activities because of physical or emotional problems, Limitations in usual role activities because of physical health problems, Bodily pain, General mental health (psychological distress and well - being), Limitations in usual role activities because of emotional problems, Vitality (energy and fatigue), General health perceptions [22]. Patients or individuals are asked to fill out the questionnaire (tick boxes) by themselves and then it is scored by a clinician or researcher. Scores for the different domains are converted and pooled using a scoring key, for a total score indicating a range of low to high QOL.

Statistical Analysis

All statistical analysis was done by using SPSS software version 21.0 and Microsoft excel - 2007. Descriptive data was presented in the form of Mean ± Standard deviation and Mean difference percentages were calculated and presented. Level of significance was kept at 5%.

Table 1: Baseline Characteristic

	Group A (15 Subjects)	Group B (15 Subjects)	Group C (15 Subjects)
Mean SD	55 (10.5)	52 (9.5)	57 (7.5)

Table 2: Statistical Analysis procedure

Test between	Statistical analysis
Between 3 groups	Analysis of Variance (ANOVA)
Within group (pre and post) for each parameter	Post hoc bonferoni test

Table 3: PPT Mean difference between 3 groups

PPT	Pre test	Post test	Differences	F Value	P Value
	Mean & SD				
Group A	5.62 (1.6)	4.48 (1.4)	0.25	53.40	<0.001
Group B	6.28 (1.6)	4.71 (1.5)			
Group C	5.24 (1.6)	3.65 (1.9)			

Table 4: KNEE ROM Mean difference between 3 groups

KNEE ROM	Pre test	Post test	Differences	F Value	P Value	Interference
	Mean & SD					
Group A	FLEXION 110 (11.6) EXTENSION (-20) 1.5	118 (12.5) (-10) 2.5	0.25	53.40	<0.003	Highly Significant
Group B	FLEXION 115 (13.6) EXTENSION (-25) 11.6	117 (1.5) (-19) 3.6				
Group C	FLEXION 110 (11.6) EXTENSION (-15) 1.7	122 (11.5) (-5) 1.9				

Table 5: WOMAC Mean difference between 3 groups

WOMAC	Pre test	Post test	Differences	F Value	P Value	Interference
	Mean & SD					
Group A	70 (1.6)	80 (1.4)	0.25	53.40	<0.004	Highly Significant
Group B	65 (1.6)	68 (1.5)				
Group C	72 (2.5)	84 (3.0)				

Table 6: Quality of life Mean difference between 3 groups

SF36	Differences	F Value	P Value
Group A	0.25	53.40	<0.001
Group B			
Group C			

4. Results

Aim of the study was to evaluate the effectiveness of Pilates exercises (Group - I) and Closed Kinematic Chain exercises (Group - II) and conventional exercises on Pain, Range of motion and Function performance in subjects with Knee Osteoarthritis. In this study subjects were assessed for Knee Pain and Function using PPT and WOMAC respectively in this study subjects were assessed for Knee Osteoarthritis underwent either Pilates Exercises or Closed Kinematic Chain Exercises which are performed for six weeks the parameters were assessed before and after exercise training [1]

In this study statistically significant result is seen in all outcome measures PPT (<0.001, Quality of life (<0.001)

ROM (<0.003), WOMAC (<0.004) and respectively. (Group - I) Pilate's exercises have showed statistically significant difference within the groups in Reducing Pain, Improving ROM & Functional performance and quality of life in subjects with Knee Osteoarthritis. In this study (Group - II) Closed Kinematic Chain exercises have showed statistically significant difference within the groups in Reducing Pain, Improving ROM & Functional performance and quality of life in subjects with Knee Osteoarthritis [15]

Pilate's method increases the sensitivity of mechanoreceptors which provide the necessary enhancement of reflex neuromuscular protective mechanism. Pilate's exercises were specifically designed to improve coordination of the entire body and also helpful in increases recruitment of muscle fibers, which brings about co - contraction of muscle and improve stimulation of Proprioception around knee joint. These exercises are effective in reducing Pain, improving lower limb muscular strength, balance, flexibility, and spinal mobility. Thereby it increases the quality of life. Hence we can conclude that patients with mild to moderate Knee Osteoarthritis can achieve significant benefits using Pilate's exercises in addition to Conventional Physiotherapy. [23]

In the present study PPT is used to assess intensity of Pain. Since there is reliability and validity is established. The result showed that Pilates exercises p value (<0.004) of PPT from pre - test to post - test are highly significant within group. Regarding the explanation of reducing pain, stimulation of mechanoreceptors associated with myelinated alpha beta and alpha delta at spinal level and high centers releasing endorphins. Our study supported by Kaur Rajinder et al., reported that Pilates exercises shows more significant improvement in Knee Proprioception, reducing Pain and Functional ability in people with Knee Osteoarthritis [24]

There were highly significant p value (<0.0001) of Knee flexion and extension range of Pilates exercises from pre - test to posttest within group. [24] Phrompaet et al. stated that prime purpose of Pilates training is to improve flexibility and general body status and also activate specific group of muscles. Some Pilates exercises like Hundred and Single leg circles contain some components of isometric exercises increase the activation of the muscle around the knee joint and to eliminate the inhibition. By training the quadriceps isometrically, motor unit activation is increased and the muscle is strengthened without triggering the pain that often comes from moving the joint against resistance. Quadriceps muscles get stronger and could absorb more of the shock in the joint, a reduction in protective muscle guarding [24, 25]

According to previous research, the weakening of femoris muscle correlates with a decrease in joint position sense and a degradation of functional performance. Furthermore, weakening of muscle strength and degradation of proprioception both affect the functional performance. These studies suggest that muscle strength and proprioception need to be improved first, in order to improve functional performance

Pilate's exercises improve physical and mental conditioning through increasing strength, flexibility balance and postural awareness by stretching and strengthening exercises. This method focuses on building motions and activities that help to strengthen minor muscles, which turns help to strengthening major muscles. Pilates exercises may affect the proprioception via mental effort focuses on activating special muscle at correct speed and control of movement [24, 25]

The results showed that Closed Kinematic Chain exercises p value (<0.0004) of PPT from pre - test to post - test had showed highly significant within group. Due to reduction in pain and consequent improvement in function fallowing quadriceps strengthening exercises have been attributed to increased stability of the knee joint which is enhanced by improvement in quadriceps muscle strength. Evidence from literature also suggests that quadriceps strengthening may activate the pain suppressing beta endorphin system, favorably alter sensory input to the central nervous system and the gate control mechanism (regulating pain perception) and as well improve blood flow and cartilage nutrition [1]

This result of the study showed significant improvement in physical function, energy role limitation pain and severity of Osteoarthritis at the post rehabilitation period. Our study finding were supported by previous study done by Vander et al. who stated that interaction between Muscle strength and Proprioception contributed significantly to the variance in functional ability and an increase of muscle strength would result in bigger improvement of functional ability. This functional status and motor control improvement might have been due to improvement in dynamic stabilization, synergistic and synchronous working of the muscle groups resulting from repetitive movements that that characterize activity of daily living

Closed Kinematic Chain exercises increases agonist recruitment and antagonistic inhibition trains all muscles to work together synergistically, occurs in all three cardinal planes, elicits concentric, eccentric and isometric contractions and facilitate proper proprioceptive feedback mechanisms. When compared between the groups Pilates exercises and Closed Kinematic Chain exercises shows statistically significant in post values. [1, 24, 25]

5. Conclusion

The result of the study shows that Pilates exercises is more effective than Closed Kinematic Chain exercises to improve the Pain, ROM, Quality of life and Functional ability of Osteoarthritis in Knee patients. [24] The improvement in Group - I is more than Group - II and having statistically highly significant. [24] The current study showed that Pilates exercise regime improved pain and functional outcomes in KOA patients, which is in line with literature. [25]

The basic theme behind Pilates Exercise is the general status and progression of adaptability, that can start muscles fibers to practice the movements. [26]

In patients with OA, the shortcoming of quadriceps and its quality of movement with hamstring is thought to be the expected variation from normal mechanics that effect the knee joint. [27]

Recommendations for Further Research

Sample size can be increased with inclusion of more number of subjects to generalize the effects of these techniques in larger population.

References

[1] Akodu AK.1, Fapojuwo OA.1, Quadri AA. Comparative *effects* of pilates and isometric exercises on pain, functional disability and range of motion in patients with knee osteoarthritis. Effects of Pilate and Isometric Exercise on knee Osteoarthritis. Res. J. of Health Sci. Vol 5 (2), April/June 2017

[2] No clear association between female hormonal aspects and osteoarthritis of the hand, hip and knee: a systematic review, Bianca M. de Klerk, DieuwkeSchiphof, Frans P. M. J. Groeneveld, Bart W. Koes, Gerjo J. V. M van Osch, Joyce B. J. van Meurs, Sita M. A. Bierma - Zeinstra. *Rheumatology*, Volume 48, Issue 9, September 2009, Pages 1160–1165, https: //doi. org/10.1093/rheumatology/kep194. Published: 16 July 2009

[3] International Journal of Multidisciplinary Research and DevelopmentOnline ISSN: 2349 - 4182, Print ISSN: 2349 - 5979; Impact Factor: RJIF 5.72Received: 20 - 01 - 2019; Accepted: 23 - 02 - 2019www.allsubjectjournal. comVolume6; Issue 3; March2019; Page No.198 - 203

[4] https: //www.ncbi. nlm. nih. gov/pmc/articles/PMC3766936

[5] Hayami T. Osteoarthritis of the knee joint as a cause of musculoskeletal ambulation disability symptom complex (MADS) Clin Calcium.2008; 18: 1574 - 80. [PubMed]

[6] Felson DT, Anderson JJ, Naimark A, Kannel W, Meenan RF. The prevalence of chondrocalcinosis in the elderly and its association with knee osteoarthritis: the Framingham Study. JRheumatol.1989; 16: 1241 - 5. [PubMed]

[7] Kisner and colby 5th edition, therapeutic exercise pg 313 - 314, 893

[8] https: //www.webmd. com/osteoarthritis/ostearthritis - of - the - knee - degenerative - arthritis - of - the - knee#2

[9] Kwon YJ, Park SJ, Jefferson J, Kim K. The Effect of Open and Closed Kinetic Chain Exercises on Dynamic Balance Ability of Normal Healthy Adults. J Phys Ther Sci.2013 Jun; 25 (6): 671–4.

[10] Bynum EB, Barrack RL, Alexander AH. Open versus closed chain kinetic exercises after anterior cruciate ligament reconstruction. A prospective randomized study. Am J Sports Med.1995 Aug; 23 (4): 401–6.

[11] Uçar M, Koca I, Eroglu M, Eroglu S, Sarp U, Arik HO, et al. Evaluation of Open and Closed Kinetic Chain Exercises in Rehabilitation Following Anterior Cruciate Ligament Reconstruction. J Phys Ther Sci.2014 Dec; 26 (12): 1875–8.

[12] 12). Akuthota V, Herring SA. Nerve and vascular injuries in sports medicine. Springer, 2009

[13] Meenakshi C1, Apparao C2, Swamy G3, Chaturvedhi P4, and Mounika R. Comparison of Pilates Exercises and Closed Kinematic Chain Exercises on Pain, Muscle Strength and Functional Performance in Subjects with Knee Osteoarthrits. iMedPub Journalswww.imedpub. com. Journal of Physiotherapy Research.2021

[14] Arch Physiother.2017; 7: 9. Published online 2017 Jul 19. doi: 10.1186/s40945 - 017 - 0036 - 6. PMCID: PMC5759897. PMID: 29340203. Effectiveness of three modes of kinetic - chain exercises on quadriceps muscle strength and thigh girth among individuals with knee osteoarthritis. Oladapo Michael Olagbegi, Babatunde Olusola Adegoke and Adesola Christiana Odole

[15] Olagbegi OM, Adegoke BOA, Odole AC. Effectiveness of combined chain exercises on pain and function in patients with knee osteoarthritis. Bangladesh J Med Sci.2016; 15 (2): 178–188. doi: 10.3329/bjms. v15i2.24808. [CrossRef] [Google Scholar]

[16] Comparison of pilates exercises and proprioceptive exercises on joint position sense in people with knee osteoarthritis, Kaur Rajinder, Kaur Harneet, Impact factor, 2014, 5.61

[17] Sohrab Ahmed Khan, 2 Mereena Baby, 3 Hammad Ahmed Siddiqui, 4 Aafreen. Comparison of Pilates exercises and conventional treatment in people with knee osteoarthritis: A pilot study. January 2018. International Journal of Yoga, Physiotherapy and Physical Education 101. International Journal of Yoga, Physiotherapy and Physical Education ISSN: 2456 - 5067. Impact Factor: RJIF 5.24 www.sportsjournal. in Volume 3; Issue 1; January 2018; Page No.101 - 105

[18] Leanna O'Hora, SPT; Erica Robbins, ATC, SPT; Logan Savidge, SPT; Brittney Tokarick, SPT; Brandt Wood, SPT; Mary Ann Holbein - Jenny, PT, DPT, PhD. September 8, 2020. American physiotherapy association

[19] Joint range of motion and manual muscle testing.3nd edition. William D. BundyNancy Reese.2017. ISBN: 978 - 1 - 4557 - 5882 - 1. Chapter 12. Pg.374

[20] Problems persist in reporting of methods and results for the WOMAC measure in hip and knee osteoarthritis trials B. Copsey, J. Y. Thompson, [. . .], and J. A. Cook. https: //www.ncbi. nlm. nih. gov/pmc/articles/PMC6373321/# Qul of life Res 2019.28 (2) 335 - 343.

[21] Ware J. SF - 36 Health Survey Update. Spine.2000.25; 24: 3130 - 3139

[22] Ware Jr., J. E. and Sherbourne, C. D. (1992) The MOS 36 - Item Short - Form Health Survey (SF - 36). I. Conceptual Framework and Item Selection. Medical Care, 30, 473 - 483.

[23] January 2022, Volume 72, Issue 1. Effect of Pilates based exercises on symptomatic knee osteoarthritis: A Randomized Controlled Trial. Welcome to Journal Of Pakistan Medical Association ISSN (Print): 0030 - 9982; ISSN (Linking): 0030 - 9982 - L

[24] Heidar S. Effects Of Pilates Exercise On Knee Osteoarthritis In Elderly Male Athletes. J Res Rehabil Sci.2011; 7: 571 - 9.

[25] Rahbar M, Shimia M, Toopchizadeh V, Abed M. Association between knee pain and low back pain. J Pak Med Assoc.2015; 65: 626 - 31

[26] Baltaci G, Tunay VB, Duzgun I, Ozer 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. OsteoarthCartil.2008: S223.

[27] 27) De Oliveira LC, De Oliveira RG, De Almeida Pires - Oliveira DA. Effects of Pilates on muscle strength, postural balance and quality of life of older adults: a randomized, controlled, clinical trial. J Phys Ther Sci.2015; 27: 871 - 6.