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Research Article

EFFICACY OF CLOSE KINEMATIC CHAIN EXERCISES IN REDUCING PAIN AND IMPROVING FUNCTIONALITY IN PATIENT'S WITH KNEE OSTEOARTHRITIS AMONG OLDER ADULTS: RANDOMIZED CONTROL TRIAL

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Abstract

Background: Osteoarthritis (OA) a degenerative, chronic illness that progressively affects the knee and hip joints. The illness progressively lowers a person's quality of life by making it harder for them to move around, be independent, and interact with others.

Methodology: A randomized controlled trial was conducted on 42 participants aged between 40 and 70 years at Santosh college of Occupational therapy. The experimental group received traditional occupational therapy treatment in addition to closed kinetic chain exercises. In addition to traditional occupational therapy treatment, participants in the control group also received a home-based program. For eight weeks, there were three sessions per week, each lasting forty-five minutes.

Results: there was a significant difference between the experimental and control groups' pain levels as determined by the Visual Analog Scale ($t = 3.053$, $p = 0.004$), suggesting that the experimental group experienced greater pain reduction. However, the groups' post-intervention WOMAC assessments did not differ statistically significantly ($t = -0.741$, $p = 0.463$), suggesting that both groups had comparable functional improvements.

Conclusion: According to the study's findings, closed kinematic chain (CKC) workouts provide better analgesic benefits than traditional exercise therapies for those with knee osteoarthritis.

Keywords: Conventional OT treatment,Mann–Whitney U Test, Osteoarthritis, Visual analogue scale, WOMAC.

1. Introduction

Osteoarthritis is a degenerative disease that gradually worsens over time, and it is not caused by inflammation. It is marked by changes in the metabolism, structure, and biochemistry of articular cartilage, ultimately leading to its degradation. These changes also impact the bone, joint capsule, synovial membrane, and adjacent muscles, typically resulting in formulation of reactive new bone at the surfaces and margins of the joint.

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Common symptoms of osteoarthritis include pain of joint, stiffness, decreased mobility of joints, diminished muscular strength, altered proprioception, instability, crepitus, and loss of function.

Osteoarthritis is considered the fourth most important reason to cause disability, significantly affecting quality of life, especially among the elderly. Among the various types of osteoarthritis, knee osteoarthritis is particularly notable as a main cause of chronic disability in older adults, due to the knee joint's vital role in weight-bearing and mobility. The functional limitations caused by knee OA often impede the performance of an individual in daily living activities (ADLs) (Saurav BM et.al.2025).

Osteoarthritis (OA) affects the knee and hip joints, representing a degenerative, chronic condition that

progresses gradually. The disease progressively diminishes an individual's capacity to move, maintain independence, and interact with others, all of which detract from overall quality of life.[1]

Symptomatic osteoarthritis of the knee is anticipated to impact 9.6% of men and 18% of women globally. Osteoarthritis ranks as the second most prevalent disease with a range of 22–39% in India. The primary process involves erosion leading to slow breakdown, formation of bone spurs, hardening of the bone beneath the cartilage, and different changes in the synovial membrane and joint capsule affecting their structure and function.[2]

Closed Kinematic Chain exercises are more functional as they engage the lower limb muscles in everyday activities. They have been noted for facilitating simultaneous segmental movement, which results in superior eccentric contraction and co-contraction of muscles. Additionally, these exercises help to minimize shear forces while introducing compression forces, thereby controlling movement across the joint and enhancing joint stability. Closed kinematic chain exercises are recognized as effective, efficient, safe and functional for building muscular strength and improving bones position .[2]
Kinetic chain workouts include lunges, squats, leg raises, pull-ups, and push-ups. With these exercises that target your legs, gluteus, core, and upper body, you may simultaneously increase your strength, balance, and agility. Kinetic chain exercises are widely used by athletes, physical therapists, and fitness enthusiasts to improve performance, lower the chance of injury, and increase fitness and health.[3]
CKC involves movements performed under weight-bearing conditions in which the lower segments of both lower extremities remain stable while the proximal segments of both upper extremities move. The exercises are standard components of rehabilitation programs, as they effectively build the strength and endurance necessary for activities of daily livings.[4]

Effective interventions are necessary for older adults to improve their functionality and reduce the pain among older adults suffering from osteoarthritis of knee joints. Thus, this present research study aims to ascertain if close kinematic chain workouts are efficient in reducing the pain and enhancing mobility among older persons suffering with knee osteoarthritis ultimately for improving their health and well-being.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

A randomized controlled trail was reviewed, discussed and approved by Institutional Ethical Committee of Santosh college of Occupational therapy **(Ref No.-SCOT/JULY-25/ECORTHO-08)**and data was collected from The Healing Touch Pediatric and Orthopedic Clinic Faridabad and Santosh medical college and Hospital, Ghaziabad to evaluate the efficacy of close kinematic chain exercises in lowering pain and increasing functionality in participants with osteoarthritis of knee joint among older adults.All participants were recruited after obtaining informed consent.

2.2 Participants

Eligible participants were older adults aged 40-70 years with a confirmed diagnosis of grade 1 or 2 knee osteoarthritis based on Kellgren-Lawrence severity scale.Inclusion criteria includesPatient diagnosed with symptomatic knee OA,classified as grade 1 or 2 knee osteoarthritis on the basis of on the basis of Kellgren-Lawrence severity scale, both Male and Femaleand patient is having a knee pain greater than or equal to two on a VAS. Exclusion criteria includes: Implanted electrical devices,neurological conditions (stroke, for example), confined to a wheelchair, current gout or systemic inflammatory arthritis, a history of hip or knee injuries, as well as a hip or knee arthroscopy during the previous six months and received an intra-articular injection in the knee, was on anticoagulant medication, had recent or planned surgery, or participated in any study pertaining to an exercise regimen during the previous six months

A total of 42 participants were recruited and randomized (1:1) into the experimental group (n=21) and control group (n=21) using computer generated random numbers.

2.3 Intervention Protocol

The intervention groups received a protocol for **eight weeks;** there were three sessions per week conducted by an occupational therapist. Each session lasted 45 minutes.

GROUP A (n=21): Experimental Group
Participants in the experimental group received a close kinematic chain exercise program plus conventional occupational therapy treatment. The intervention focused on improving proprioception, postural control, balance, neuromuscular coordination, and functional performance through CKCs exercises.

Table: 1 CLOSE KINEMATIC CHAIN EXERCISES (Ng WH, Jamaludin NI et.al. 2022)

S. No.	Activities (CKCEs)	Repetitions	Duration
1.	Standing exercises for terminal end extension (maximum 15° knee flexion)	10	45mintues/3days for 8 weeks
2.	Wall sliding exercises	10	
3.	Forward step-up exercises	10	
4.	Sidestep up exercises	10	
5.	Self-stretching (Quadriceps &Hamstrings)	10	

GROUP B (n=21): Control Group

Participants in the control group received the home-based intervention plus conventional occupational therapy treatment for knee osteoarthritis aimed at improving joint mobility, muscle strength, flexibility, and functional ability.

Table: 2 HOME BASED EXERCISES (MUNSHI TK, Parmar CJ et.al.2023)

S. No	Activities (Otago exercises)	Repetitions	Duration
1.	Knee strengthening exercises (front and back approach)	10	45 minutes/3days for 8 weeks
2.	Sit to stand	10	
3.	Calf raise and toe raise	10	
4.	Heel to toe walk (forward and backward approach)	10	
5.	Side hip strengthening	10	
6.	Walking on stairs	10	

Table: 3 Conventional Occupational Therapy Program (Viswas S, Vaidya VK et.al.2021)

S. No.	Activities (strengthening exercises)	Repetitions	Duration
1.	Exercise for the isometric quadriceps	10	45mintues/3days for 8 weeks
2.	Straight-leg descent	10	
3.	Straight-leg elevation	10	
4.	Short arc terminal knee extension	10	
5.	Full arc terminal knee extension	10	

2.4 Outcome Measures

The following standardized outcome measures were used pre and post completion of intervention. WOMAC scale is utilized to evaluate the knee-related functional status&Visual Analogue Scale (VAS) which is utilized to evaluate the pain.

2.5 Statistical Analysis

The Healing Touch Pediatric and Orthopedic Clinic in Faridabad and Santosh Hospital in Ghaziabad conducted a randomized controlled trial study with 42 participants. Following the completion of all evaluations (both pre- and post-intervention), data were gathered, entered into a master chart, and analyzed using IBM Statistics Version 26 to determine statistical significance. Nonparametric tests were performed to analyze the preand postdata of the experimental and control groups. For analysis of the visual analogue scale (VAS) and WOMAC scale outcomes theMann–Whitney U Test was done.

3.0 RESULTS

Overall, the findings indicate that close kinematic chain exercises were effective in significantly lowering knee osteoarthritis pain in older adults, especially in the experimental group. Functional improvement was observed in both groups; however, the magnitude of improvement did not differ significantly between groups post-intervention. Based on these results, the alternate hypothesis (H_1) is partially accepted, demonstrating significant efficacy of close kinematic chain exercises in pain reduction, while the null hypothesis (H_0) is rejected for pain outcomes but retained for functional outcomes as measured by WOMAC.

Table:4. Demography Analysis of Control Vs Experimental Group

Variable	Category	Control Group (n = 21)	Experimental Group (n = 21)
Age (years)	Mean ± SD	55.43 ± 10.53	55.95 ± 8.49
Sex	Male	16 (76.19%)	13 (61.90%)
	Female	5 (23.81%)	8 (38.10%)

Participants in both groups shared similar demographics. Both groups' mean ages were comparable, and each group's gender distribution revealed a preponderance of men, indicating baseline homogeneity.

Table: 5Baseline Assessment of Pre-Data Analysis

Scale	t value	P value	Interpretation
Pre-OT VAS (Control vs Experimental)	−0.738	0.466	No, statistically significant difference
Pre-OT WOMAC (Control vs Experimental)	−1.706	0.098	No, statistically significant difference

The experimental and control groups' pre-OT VAS and WOMAC ratings do not differ statistically significantly ($p > 0.05$). This implies that both groups were comparable at baseline before the intervention.

Table: 6Post-Data Analysis of the outcome variable

Scale	t value	P value	Interpretation
Post-OT VAS (Control vs Experimental)	3.053	0.004	Statistically significant difference
Post-OT WOMAC (Control vs Experimental)	−0.741	0.0463	statistically significant difference

The experimental and control groups' VAS scores differed statistically significantly (p) after the intervention. (< 0.05), suggesting that one group experienced better pain relief. The groups' post-OT WOMAC assessments, however, were not statistically significantly different($p > 0.05$).

Table: 7 Group Analysis Pre and Post between VAS and WOMAC Scores (Mann–Whitney U Test)

Test Statistics[a]				
	PRE VAS	POST VAS	PRE WOMAC	POST WOMAC
Mann-Whitney U	174.000	120.500	132.000	191.000
Wilcoxon W	405.000	351.500	363.000	422.000
Z	-1.190	-2.609	-2.228	-.743
Asymp. Sig. (2-tailed)	.234	.009	.026	.458
a. Grouping Variable: Group				

The groups' pre-VAS and post-WOMAC evaluations did not differ statistically significantly ($p > 0.05$), according to the non-parametric analysis. Nonetheless, the post-VAS & pre-WOMAC ratings differed statistically significantly ($p < 0.05$), indicating significant group differences in baseline functional status and pain reduction.

Table: 8 Within-Group Comparing the Pre & Post-Intervention VAS & WOMAC Scores Using t-Test

Independent Samples Test							
Stats	**Levene's Equalityof Variance Test.**		**t-test for mean Equality**				
Stats	**F**	**Sig.**	**T**	**Significance**	**Mean Difference**	**95% Confidence Interval of the Difference**	
				Two-Sided p		**Lower**	**Upper**
PRE VAS	5.9	0.02	-1.331	0.191	-0.714	-1.799	0.371
			-1.331	0.192	-0.714	-1.803	0.375
POST VAS	4.33	0.044	3.053	0.004	1.143	0.386	1.899
			3.053	0.004	1.143	0.384	1.902
PRE WOMAC	0.55	0.462	-2.317	0.026	-7.238	-13.552	-0.925
			-2.317	0.026	-7.238	-13.559	-0.918
POST WOMAC	0.38	0.544	-0.741	0.463	-1.905	-7.097	3.288
			-0.741	0.463	-1.905	-7.101	3.292

The pre-VAS & post-WOMAC evaluations did not differ statistically significantly ($p > 0.05$) between the experimental & control groups, according to an independent samples t-test, suggesting baseline comparability and comparable functional outcomes following intervention.

.4 DISCUSSION

The present study assessed how well close kinematic chain (CKC) exercises affected knee osteoarthritis patients' pain and functional outcomes. In compliance with the inclusion and exclusion standards, 42 participants in total were recruited from Santosh Hospital and The Healing Touch Paediatric and Orthopaedic Clinic. They were divided equally into control and experimental groups, and baseline comparability was established with regard to age, gender distribution, pain intensity, and functional status. Due to degenerative changes in joint cartilage and surrounding structures, knee osteoarthritis typically affects people over 50

The mean age of participants in both groups was similar and consistent with the typical age range reported for this condition. The study's internal validity is further strengthened by the comparatively balanced gender distribution, which also lessens the possibility that gender-related bias will affect the results.

Before the intervention, homogeneity was confirmed by baseline analysis, Results demonstrated that neither pain (VAS) nor functional status (WOMAC) differed statistically significantly between the control and experimental groups. This result is crucial because it confirms that any observed post-intervention differences can be linked to the intervention rather than pre-existing disparities. To guarantee significant between-group comparisons in exercise-based intervention studies involving knee osteoarthritis, similar baseline equivalency has been highlighted as a requirement **(Bennell et al., 2014).**

After the intervention period, both groups showed improvements in functional outcomes and a decrease in pain intensity. The control group showed modest gains in VAS and WOMAC ratings, which could be explained by regular care and traditional therapeutic exercises. By strengthening the muscles surrounding the knee and lowering joint loading, general strengthening and mobility exercises have been shown to improve joint function and lessen pain **(Fransen, M et al., 2015).**

However, the experimental group demonstrated a much bigger reduction in pain intensity, as

evidenced by a larger decline in mean VAS scores after the intervention.

CKC exercises were more successful in reducing pain than the control intervention, according to the significant between-group difference in post-intervention VAS scores. The benefits of CKC exercisesinbiomechanicsand neuromuscular function, promoting co-contraction of opposing muscle groups, improve joint stability and distribute forces more uniformly across the knee joint, potentially explaining this enhanced pain relief effect. (Escamilla et al., 1998). In people with knee osteoarthritis, increased proprioceptive input and decreased shear forces during CKC movements may further aid in pain modulation **(Mikkelsen et al., 2000).**

In contrast, although both groups showed within-group functional improvement, post-intervention WOMAC scores did not reveal significant difference is present between both groups. The result indicates that the CKC exercises might provide better pain relief; functional gains might rely on a variety of factors, which include the duration of the intervention, the grade of osteoarthritis, and psychosocial

influences. Longer intervention times and multifacete d strategies focusing on strength, endurance, balance, and activity modification are frequently necessary for functional gains **(Hurley, M et al., 2018).**

WOMAC scores did not significantly change after the intervention, which is consistent with earlier research showing that short-term exercise regimens may produce functional results that are similar for various exercise modalities **(Roddy, E, et al., 2005).**

Within-group analysis further supports the efficacy of CKC exercises, as the experimental group demonstrated statistically significant reductions in pain and meaningful functional improvement from pre- to post-intervention. The significant mean difference in VAS scores and the narrow confidence interval indicate a clinically relevant reduction in pain, reinforcing the therapeutic value of CKC exercises in knee osteoarthritis management. These outcomes are consistent with earlier research evaluation highlighting the effect of closed chain strengthening in improving pain and joint control in degenerative knee conditions **(Jan, M. et al., 2009).**

J. Harrison. Michael, Adam I, Lok Sze Katrina Li, Harrison D. Pham. Mark J. Semciw. Scholes, Matthew G., and Madeline Hanningtonthe Efficacy of Closed Versus Open Kinetic Chain Exercise in Knee Osteoarthritis—A Systematic Review and Meta-Analysis was carried out in 2025. According to this study, that concluded the CKC exercise showed more effectiveresults on pain and physical function than OKC exercise amongindividuals with knee OA in the short term**[5]**

June Kang, Ja Yeon Lee, and Il Bong Park conducted a study onClose Versus Open Kinetic Chains: Exercise Effects onPressure of Centre and Y Balance in Middle Older Women with Osteoarthritis of the knee joint—A Randomized Controlled Trial in 2025. For middle-aged women suffering from osteoarthritis in their knees, aprogram that emphasized abduction and external rotation of hip joint enhanced static and dynamic equilibrium widely and consistently as compared to an OKC program **(Kang J et al., 2025).**

The Efficiency of Open versus Closed Kinetic Chain Exercises effect on Dynamic Balance and Health in Individuals with Osteoarthritis of Knee Joint: A Quasi-Experimental Study was carried out in 2022 by **Roopa Rajendra Desai, Ashwini Ravindranath Damsam, and Tushar Jaikrishna Palekar.**OKC and CKC exercises enhanced dynamic balance, decreased discomfort and stiffness, and enhanced functional mobility in patients with knee osteoarthritis after four weeks. However, physical function was enhanced more by CKC workouts**[6]**

The results of present study indicate that close kinematic chain exercises are effectively reducing the pain among individuals with knee osteoarthritis, with greater benefits observed in the experimental group.The lack of a significant between group difference in WOMAC ratings indicates that CKC exercises may not provide extra short-term functional benefits over traditional therapies, even though both groups showed functional gains. Consequently, the alternate hypothesis is partially accepted, supporting the effectiveness of CKC exercises in pain reduction, while the null hypothesis is retained for functional outcomes. These findings underscore the importance of incorporating CKC exercises as a key component for pain relief strategies in knee osteoarthritis, it highlights the need for longer-duration or combined interventions to achieve superior functional outcomes.

5.0 CONCLUSION

According to the present study, closed kinematic chain (CKC) exercises have better analgesic benefits than traditional exercise interventions when it comes to lowering pain in people with osteoarthritis in the knee. Both the groups (A & B) showed notable reduction for bilateral knee pain and functional status after the intervention, however the experimental group's decrease in pain intensity was noticeably greater.However, neither group's mobility results differed statistically significantly, suggesting that short-term exercise programs for CKC may not offer any additional functional benefits above standard therapy. Overall, longer-duration or combined therapeutic approaches may be necessary to achieve greater functional gains, but CKC exercises can be suggested as an effective part of pain management in knee osteoarthritis.

6.0 DECLARATIONS & ETHICAL STATEMENTS

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Authors' Contributions: TS conceptualized the study, drafted the protocol, carried out data collection, and wrote the initial manuscript draft. RKS supervised the project and critically revised the manuscriptSD revised the manuscript and managed the submission process. Every author reviewed and endorsed the final manuscript.

Ethical Approval and Consent: Ethical Clearance no.: SCOT/JULY-25/ECORTHO-08 Informed patient consent was obtained from all individual participants included in the study for both intervention participation and publication of data.
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Conflict of Interest Statement: Writers announced they have no competing interests.
Data Availability Statement: Data generated &investigated materials for this study were available from the corresponding author on a request.

1. **AI Disclosure:** Artificial intelligence tools were not used in the conceptualization, execution, data analysis, or manuscript drafting of this study.

7. Conflict of Interest: Nil

8. References:

1. Büyükyılmaz G, Menek B, Tarakçı D. Closed kinetic chain exercises therapy versus Wii-based exergame therapy in the treatment of knee osteoarthritis: randomized controlled trial. Arch Health Sci Res. 2024;11(2):133-139. DOI: https://doi.org/10.5152/ArcHealthSciRes.2024.23139

2. Meenakshi C, Apparao C, Swamy G, Chaturvedhi P, Mounika R. Comparison of Pilates exercises and closed kinematic chain exercises on pain, muscle strength and functional performance in subjects with knee osteoarthritis. J Physiother Res. 2021;5(1):1-6. DOI: https://doi.org/10.1080/07853890.2025.2540616

3. .Hossain A. *Effectiveness of Kinetic Chain Exercise in Patients with Knee Joint Osteoarthritis: A Randomized Control* (Doctoral dissertation, Bangladesh Health Professions Institute, Faculty of Medicine, the University of Dhaka, Bangladesh). DOI: 10.7759/cureus.89674

4. Kang J, Lee JY, Park IB. Open versus closed kinetic chain: impacts of exercise on centre of pressure and Y-balance in middle-aged women suffering from knee osteoarthritis—A randomized controlled study. Healthcare (Basel). 2025 Aug 30;13(17):2173. DOI: https://doi.org/10.3390/healthcare13172173

5. Michael HJ, Pham HD, Li LS, Semciw AI, Scholes MJ, Hannington M, King MG. The Efficacy of Closed Versus Open Kinetic Chain Exercise in Knee Osteoarthritis—A Systematic Review and Meta-Analysis. Physiotherapy Research International. 2025 Oct;30(4):e70105. DOI: https://doi.org/10.1002/pri.70105

6. Desai RR, Damsam AR, Palekar TJ. Efficacy of open versus closed kinetic chain exercises on dynamic balance and health status in individuals with osteoarthritis of knee joint: a quasi-experimental study. J Clin Diagn Res. 2022 Aug;16(8): YC05-YC09. DOI: https://doi.org/10.7860/JCDR/2022/51079.16766