RESEARCH ARTICLE

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Impact of Closed Kinetic Chain and Resistance Training on Physical and Functional Outcomes in OA Knee Patients with Sarcopenia: A Quasi-Experimental Approach

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Abstract

Background: Osteoarthritis (OA) is a major global health concern causing chronic joint pain, reduced function, and lower quality of life. Sarcopenia, the age-related decline in muscle mass and strength, contributes to muscle weakness. Closed kinetic chain exercises and resistance training are effective in reducing pain, improving function and enhancing muscle mass, strength, and overall health to combat aging effects in patients with OA knee with Sarcopenia. **Aim:** The aim of this study is to compare the effectiveness of closed kinetic chain exercises and resistance training exercises in improving physical function and managing symptoms in individuals with knee Osteoarthritis (OA) and sarcopenia. **Method:** A total of 36 participants, meeting inclusion criteria, were recruited and divided into two groups: Group A received CKC exercises, while Group B underwent RT, with interventions conducted thrice weekly for 6 weeks. Outcomes were measured using SARC-F, VAS, 5 times Chair Stand (5-CS) Test, Timed Up and Go (TUG) test, and Lower Extremity Functional Scale (LEFS). Result: The study showed statistically significant improvements ($p < 0.05$) across all measures for both groups, with Group B (resistance training) exhibiting greater clinical significance. This indicates that resistance training may offer superior benefits for individuals with knee Osteoarthritis and Sarcopenia. **Conclusion:** Both closed kinetic chain and resistance training exercises resulted in significant improvements in pain, physical, and functional outcomes after 6 weeks. Resistance Training demonstrated greater clinical significance in OA patients with sarcopenia. **Major Findings:** Both closed kinetic chain exercises and resistance training significantly improved outcomes in individuals with knee Osteoarthritis and sarcopenia. However, resistance training demonstrated superior clinical benefits, particularly in reducing pain and enhancing functional performance, suggesting it as a more effective intervention for this population.

Keywords: Closed Kinetic Chain Exercise, Lower Extremity Functional Scale, Osteoarthritis Knee, Resistance Training, Sarcopenia

1. Introduction

Osteoarthritis (OA) presents a significant global health issue, characterized by chronic joint pain, diminished functional ability, and decreased quality of life. Its prevalence is closely tied to an aging population and rising obesity rates worldwide. OA places a substantial burden on healthcare systems, leading to frequent hospital visits annually in developed countries. Persistent OA in lower limb joints can reduce physical fitness, potentially increasing the risk of cardio metabolic conditions and premature death[1]. Chronic knee Osteoarthritis is characterized by symptoms such as pain, swelling which can contribute to postural deformities. Over time, these deformities can cause muscles to stiffen and become

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immobile, leading to decreased flexibility and abnormal walking patterns[2]. While various types of exercise are recognized for effectively reducing pain and enhancing physical function in individuals with knee Osteoarthritis (OA), there is still limited clarity on which forms of exercise are the most effective.

Exercises for knee conditions are typically performed using either Open Kinetic Chain Exercises (OKCE) or Closed Kinetic Chain Exercises (CKCE). Studies have compared the effects of OKCE and CKCE in patients with knee Osteoarthritis (OA)[3]. Research demonstrates that both OKCE and CKCE effectively improve quadriceps muscle strength, which plays a crucial role in managing OA. Strengthening the quadriceps is essential as it helps stabilize the knee joint, reduce pain, and improve functional mobility, ultimately mitigating the progression and impact of Osteoarthritis. Various exercise regimens, including strength training, aerobic exercises, walking programs, aquatic exercises, water jogging, yoga, and Tai Chi, are utilized in the management of knee osteoarthritis[1,4].

Sarcopenia, characterized by age-related decline in muscle mass and function, is increasingly prevalent among older adults, impacting overall health and increasing risks of falls, fractures, and mortality. The prevalence of Sarcopenia rises with age. As the global population of older adults increases rapidly, so too will the number and proportion of older adults affected by Sarcopenia[5]. Skeletal muscle quality and function naturally decline with age. Previous studies indicate that skeletal muscle mass decreases at a rate of 1-2 % per year after the age of 50, while muscle strength declines by 1.5% between ages 50 and 60, potentially leading to Sarcopenia[6].

Sarcopenia is now recognized as a distinct medical condition and has been assigned its own code in the International Classification of Diseases, 10th revision (ICD-10). The specific code for Sarcopenia is M62.84[7]. The SARC-F is regarded as a valuable, straightforward, and cost-effective tool for initial Sarcopenia screening. Developed as a self-administered questionnaire, SARCF comprises five questions that focus on the key features and outcomes associated with Sarcopenia[7,8]. The SARC-F questionnaire consists of five items: Strength, assistance with walking, rising from a chair, climbing stairs, and falls. A cumulative score of ≥ 4 is recommended as a screening threshold for Sarcopenia in primary care settings[9].

Given the high prevalence of Osteoarthritis (OA) and Sarcopenia, their frequent co-occurrence suggests potential interactions between them. Biomechanical changes due to altered bone and periarticular muscle interactions may contribute to muscle atrophy or weakness. These factors could influence the onset, progression, and severity of OA. The relationship between Osteoarthritis (OA) and Sarcopenia is complex and multifaceted, influenced by a common mechanism of chronic low-grade inflammation and a range of contributing factors and lifestyle influences[10]. Physical training has emerged as a promising intervention to mitigate age-related muscle mass and strength decline. Among various training methods, resistance training stands out as particularly effective for enhancing muscle mass and strength in older individuals. It facilitates improvements in body composition and muscle strength, thereby mitigating the detrimental effects of aging. Research has consistently supported the efficacy of resistance training in older adults with Sarcopenia[9,11].

Chronic musculoskeletal pain associated with OA can exacerbate Sarcopenia by limiting physical activity, further complicating management strategies. OA and Sarcopenia represent significant challenges in geriatric care, underscoring the importance of personalized exercise interventions and comprehensive healthcare strategies to mitigate their impact on older individual's health and well-being[10]. No medications are currently approved for treating Sarcopenia, with physical exercise being recognized as the most effective intervention for managing this condition[10]. In the absence of effective drugs for treating Sarcopenia, non-pharmacological interventions offer an effective alternative to slow down its progression[9]. Exercise is widely recognized as the primary intervention for Sarcopenia in clinical practice. However, conflicting evidence exists regarding the most effective type of exercise. Exercise programs for Sarcopenia exhibit considerable variation in types such as resistance training, aerobic exercises, balance training, or multicomponent approaches[10].

This study is essential to identify the most effective exercise interventions for individuals with knee Osteoarthritis and Sarcopenia, focusing on the best treatment for improving overall well-being. By comparing closed kinetic chain exercises and resistance training, the study aims to offer evidence-based recommendations for enhancing outcomes in this at-risk population.

The 6-week intervention period was chosen based on previous studies that demonstrated positive short-term improvements in pain reduction and mobility in

individuals with knee Osteoarthritis (OA) and Sarcopenia (Petersson *et al.*)[11]. This duration allows for meaningful functional changes, and while longer interventions may offer additional benefits, the 6-week timeframe provides a practical and effective window for assessing immediate improvements in physical function

2. Materials and Methods

The study employed a Randomized Controlled Trial (RCT) design with an alternate allocation method (Envelope method) to assign participants to Group A and Group B. Outcome assessors were blinded to group allocation during post-test assessments, and data analysts were blinded during statistical analysis to minimize bias. These measures ensure the integrity of the results.

2.1 Participant Selection

The 36 participants were randomly allocated into 2 groups using the Envelope method with a 1:1 ratio: Group A (Closed Kinetic Chain Exercise, n = 18) and Group B (Resistance Training Exercise, n = 18).

2.2 Duration and Type of Study

An experimental study was carried out for both the groups in which a specifically designed treatment protocol for individual group was applied by which the treatment duration of 6 weeks and the study duration of 6 months. The study design followed Quasi-experimental study.

2.3 Sampling Method

The study took place in physiotherapy clinics run by Dayananda Sagar Institutions in and around Bangalore, where the individuals with Osteoarthritis (OA) knee with Sarcopenia according to the inclusion and exclusion criteria.

2.4 Sample Size Calculation

Sample size was calculated with the following parameters:

1. Significance level (α): 5%
2. Power (1-β): 80%
3. Effect size (Δ): 0.75

The formula used:

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2}{\Delta^2} + \frac{(Z_{1-\alpha/2})^2}{2}$$

Δ = Effect size (0.75)

1 − β = Power (80%)

$$n = \frac{(1.96 + 0.84)^2}{(0.75)^2} + \frac{(1.96)^2}{2} = 16$$

Anticipated drop outs (10%)

Thus, the sample size for this study is determined as 16 + 2 = 18 (Each group).

2.5 Inclusion Criteria

In this study, baseline characteristics of participants, including age, BMI, disease stage (Kellgren-Lawrence Grade 2 or 3), and initial functional status (assessed using SARC-F, VAS, TUG, 5-CS, and LEFS), were carefully documented to ensure comparability between the two groups[12]. The study included adults aged 60 to 80 years with a confirmed diagnosis of knee Osteoarthritis (OA) in stages 2 or 3, who were willing to voluntarily participate and provide informed consent. Both male and female participants were considered, with eligibility requiring a SARC-F score of 4 or higher, indicating Sarcopenia risk.

2.6 Exclusion Criteria

Exclusion criteria encompassed recent trauma, neurological disorders, Rheumatoid Arthritis (RA), cognitive impairments, uncooperative behavior, a history of Total Knee Replacement (TKR), or inability to follow the study protocol.

2.7 Data Collection Procedure

The study was approved by Clinical Trials Registry India (ICMR-NIMS) with a registration number for the ethical clearance (CTRI/2024/04/083233). The subjects were explained about the purpose and procedure of the study. Informed consent form was obtained. After this, subjects were allocated to groups either to closed kinetic chain exercise or resistance training exercise using the Envelope method. Prior to the intervention, a pre-test was conducted to assess baseline values for all outcome measures using SARC-F, visual analogue scale, timed up and go test, 5 times chair to stand test and lower extremity function scale. Intervention was given for 6 weeks, 3 days a week every alternate days for both the groups after which post-test assessment was done after completion of the study

2.7.1 Intervention

Ultrasound therapy was administered for 8 minutes per session using a therapeutic ultrasound device set to a frequency of 1 MHz and an intensity of 1.0 W/cm². The continuous mode was utilized throughout the entire 8-minute duration to promote pain relief and tissue healing. This protocol, consistent with previous studies on ultrasound therapy for Osteoarthritis (Altan *et al.*), was applied to both groups in the study[13].

Group A: Closed Kinetic Chain Exercise (CKCE)

Following the pre-test assessment, participants in Group A commenced a 6-week intervention program. Each session began with 8 minutes of ultrasound therapy to reduce pain and inflammation, followed by a series of structured closed kinetic chain exercises targeting strength and mobility in individuals with knee osteoarthritis. The exercises included:

1. Standing terminal knee extensions.
2. Wall slide exercises.
3. Forward step-ups.
4. Side step-ups.
5. Isometric holds.

Each exercise was performed with specific parameters:

1. Repetitions: 10-15 per set
2. Sets: 3 sets per exercise
3. Rest period: 30-60 seconds between sets
4. Frequency: 3 sessions per week

The program was individualized based on pre-test results, ensuring appropriate intensity and progression for each participant. The focus was on gradual increases in load, maintaining proper form, and minimizing the risk of injury. This protocol, informed by prior studies, aimed to enhance strength and functional mobility, ultimately improving quality of life for those with knee Osteoarthritis[14,15]

Group B: Resistance Training Exercise (RTE)

Participants in Group B began a 6-week resistance training program following the pre-test assessment. The program consisted of three 45-minute sessions per week. Each session started with 8 minutes of ultrasound therapy, followed by resistance training exercises designed to improve strength and functionality in individuals with knee osteoarthritis. The resistance exercises included:

1. Leg presses.
2. Leg curls.
3. Mini squats.
4. Calf raises.
5. Isometric holds.

The training program followed a progressive overload model, gradually increasing the intensity each week. The key parameters for each exercise were:

1. Repetitions: 10-12 per set.
2. Sets: 3-4 sets per exercise.
3. Rest period: 60-90 seconds between sets.
4. Progression: Intensity was increased either by adding resistance or increasing repetitions based on the participant's ability and progress.

Sessions were structured to ensure proper form and avoid overexertion, in line with established resistance training guidelines for knee Osteoarthritis. This protocol aimed to improve strength, endurance, and mobility while minimizing injury risk and optimizing functional outcomes[16]

3. Protocol

3.1 Outcome Measure

1. SARC-F: The SARC-F is a screening tool with five questions assessing strength, walking assistance, rising from a chair, climbing stairs, and falls. A score of 4 or higher identifies individuals at risk of Sarcopenia, helping to select participants who may benefit from exercises targeting muscle strength and function in knee osteoarthritis[5,7].
2. VAS: Pain intensity was assessed using the VAS, where participants rated pain from 0 (no pain) to 10 (worst pain) both at rest and during movement, helping evaluate the effectiveness of interventions in reducing pain, a major barrier to mobility and daily function in knee Osteoarthritis[4,17].
3. TUG Test: The TUG test measures mobility and balance by timing participants as they rise from a chair, walk three meters, turn, return, and sit down. It helps assess functional limitations and track improvements in movement efficiency and safety in individuals with knee osteoarthritis[18].

4. 5 Times Chair-to-stand Test: This test evaluates lower limb strength and functional mobility by timing how quickly participants can rise and sit down 5 times with arms folded. It provides insight into how interventions affect strength and mobility in individuals with knee Osteoarthritis and Sarcopenia[19].
5. Lower Extremity Function Scale: The LEFS is a self-reported tool assessing functional status in individuals with lower extremity limitations, covering activities such as walking, lifting objects, and performing daily tasks. It offers a comprehensive view of the impact of knee osteoarthritis on daily life and evaluates intervention effectiveness in improving functional capacity and quality of life[20].

3.2 Tailored Exercise Program for Group A and Group B

Table 1. Group A-closed kinetic chain exercise

Dosage							
S. No	Exercise	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
1	Standing terminal extension	10 reps *3 sets (10secs hold)	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 15secs hold	10 reps * 3 sets 20secs hold	10 reps * 3 sets 20secs hold
2	Wall slide exercise	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 20secs hold*	10 reps * 3 sets 20secs hold*
3	Step up forward	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 20secs hold*	10 reps * 3 sets 20secs hold*
4	Step up side	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 20secs hold*	10 reps * 3 sets 20secs hold*
5	Isometrics	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 10secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 15secs hold*	10 reps * 3 sets 20secs hold*	10 reps * 3 sets 20secs hold*

4. Consort Flow Diagram

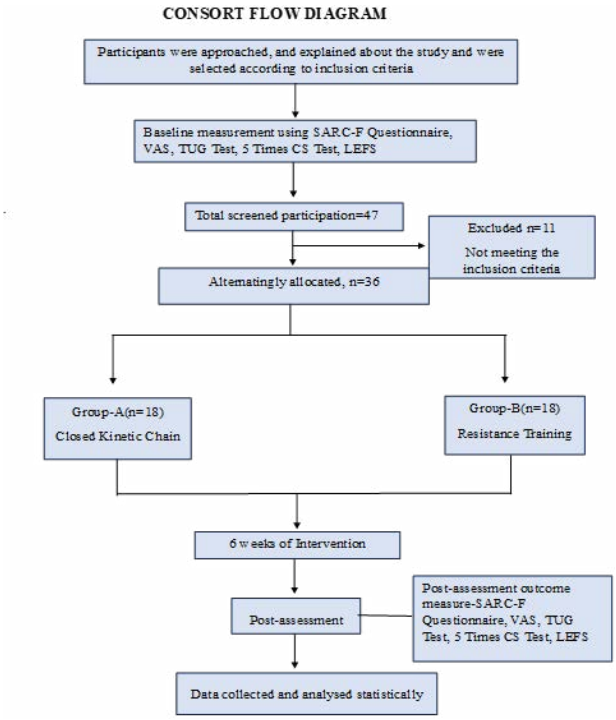


Figure 1. Consort flow diagram.

5. Statistical Analysis

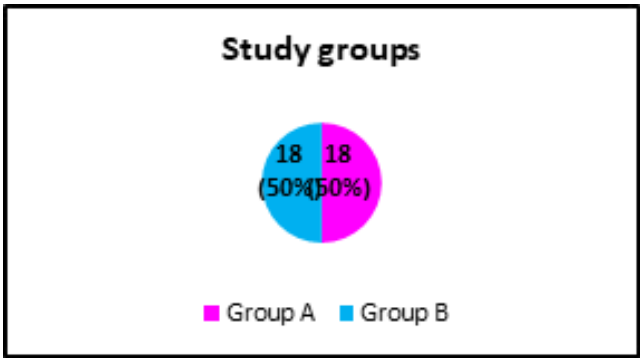
The data were analyzed using descriptive statistics, including frequency, percentage, mean, and Standard Deviation (S.D). To compare variables such as age, BMI, VAS, SARC-F, 5 Times Chair Stand (CS) test (seconds), TUG test (seconds), and LEFS scores between genders and groups, an independent samples t-test was performed. A paired t-test was used to compare changes in VAS, SARC-F, 5 Times Chair Stand (CS) test (seconds), TUG test (seconds), and LEFS scores within each group and across both groups. The Chi-square test was applied to compare gender distribution between the groups. To assess correlations between VAS, SARC-F, 5 Times Chair Stand (CS) test (seconds), TUG test (seconds), LEFS, age, and BMI, Pearson's correlation coefficient ("r") was calculated. A p-value of < 0.05 was considered statistically significant. All data analysis was conducted using SPSS software (version 29.0.10, SPSS Inc.; Chicago, IL).

6. Results

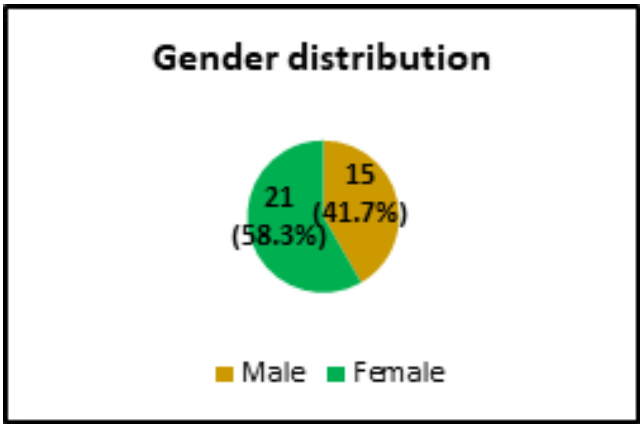
A total of 36 subjects were included in the study and all subjects completed the follow up at 6 weeks. Hence

Table 2. Group B- resistance training exercise

Dosage							
S. No	Exercise	Week 1	Week 2	Week 3	Week4	Week 5	Week 6
1	Leg press	10reps *3sets* 10secs	10reps *3sets* 10secs	10reps *3sets* 15secs	10reps *3sets* 15 secs	10reps *3sets* 20 secs	10reps *3sets* 20 secs
2	Leg curl	10reps *3sets* 10 secs	10reps *3sets* 10secs	10reps *3sets* 15secs	10reps *3sets* 15 secs	10reps *3sets* 20 secs	10reps *3sets* 20 secs
3	Mini squat	10reps *3sets* 10secs	10reps *3sets* 10secs	10reps *3sets* 15secs	10reps *3sets* 15 secs	10reps *3sets* 20 secs	10reps *3sets* 20 secs
4	Calf raise	10reps *3sets* 10secs	10reps *3sets* 10secs	10reps *3sets* 15secs	10reps *3sets* 15 secs	10reps *3sets* 20 secs	10reps *3sets* 20 secs
5	Isometrics	10reps *3sets* 10secs	10reps *3sets* 10secs	10reps *3sets* 15secs	10reps *3sets* 15 secs	10reps *3sets* 20 secs	10reps *3sets* 20 secs



Graph 1. Study groups.



Graph 2. Gender distribution.

the study results were analyzed with 36 subjects. The exercise adherence rate was observed to be excellent and all subjects adhered to Group A and Group B tailored exercise program and after 6 weeks the post test was measured. Adherence to the intervention was actively monitored throughout the study. The average attendance rate was 90%, indicating strong engagement with the exercise programs. In the case of dropouts, detailed records were maintained, and an intent-to-treat analysis was performed. This statistical approach ensures that all participants, even those who dropped out or had missing data, were included in the final analysis, thereby minimizing bias and providing a more accurate reflection of the intervention's effect.

Table 3. Descriptive statistics for age, and BMI

(n = 36)	Range	Mean	S.D.
Age (Years)	64 to 79	71.14	3.94
BMI (Kg/M^2)	19.2 to 37.8	25.61	4.35

Table 4. Comparison of VAS, SARC-F, 5 TIMES CS (seconds), TUG TEST (seconds) and LEFS within the group's pre and post test

		Group A				Group B			
		Mean	S.D.	"t"	p value	Mean	S.D.	"t"	p value
VAS	Pre-test	6.79	0.92	14.40	< 0.001*	6.72	1.13	11.35	< 0.001*
	Post-test	3.88	1.17			4.00	1.09		
SARC-F	Pre-test	6.41	1.00	10.29	< 0.001*	6.00	1.14	8.57	< 0.001*
	Post-test	3.59	1.12			3.72	0.67		
5 TIMES CS (Seconds)	Pre-test	19.74	4.85	8.66	< 0.001*	19.31	4.46	5.83	< 0.001*
	Post-test	15.84	5.28			15.27	3.89		
TUG TEST (Seconds)	Pre-test	18.72	5.12	6.98	< 0.001*	17.96	4.40	5.04	< 0.001*
	Post-test	14.92	4.43			14.63	3.70		
LEFS	Pre-test	29.41	5.09	-9.67	< 0.001*	30.22	4.91	-8.20	< 0.001*
	Post-test	40.65	5.61			41.06	5.34		

("t" = Paired "t" test; * Significant)

Table-3 presents the descriptive statistics for age and Body Mass Index (BMI) among the 36 participants. The participants ages range from 64 to 79 years, with a mean age of 71.14 years and a standard deviation of 3.94 years. For BMI, which ranges from 19.2 to 37.8 kg/m^2, the mean value is 25.61 kg/m^2 with a standard deviation of

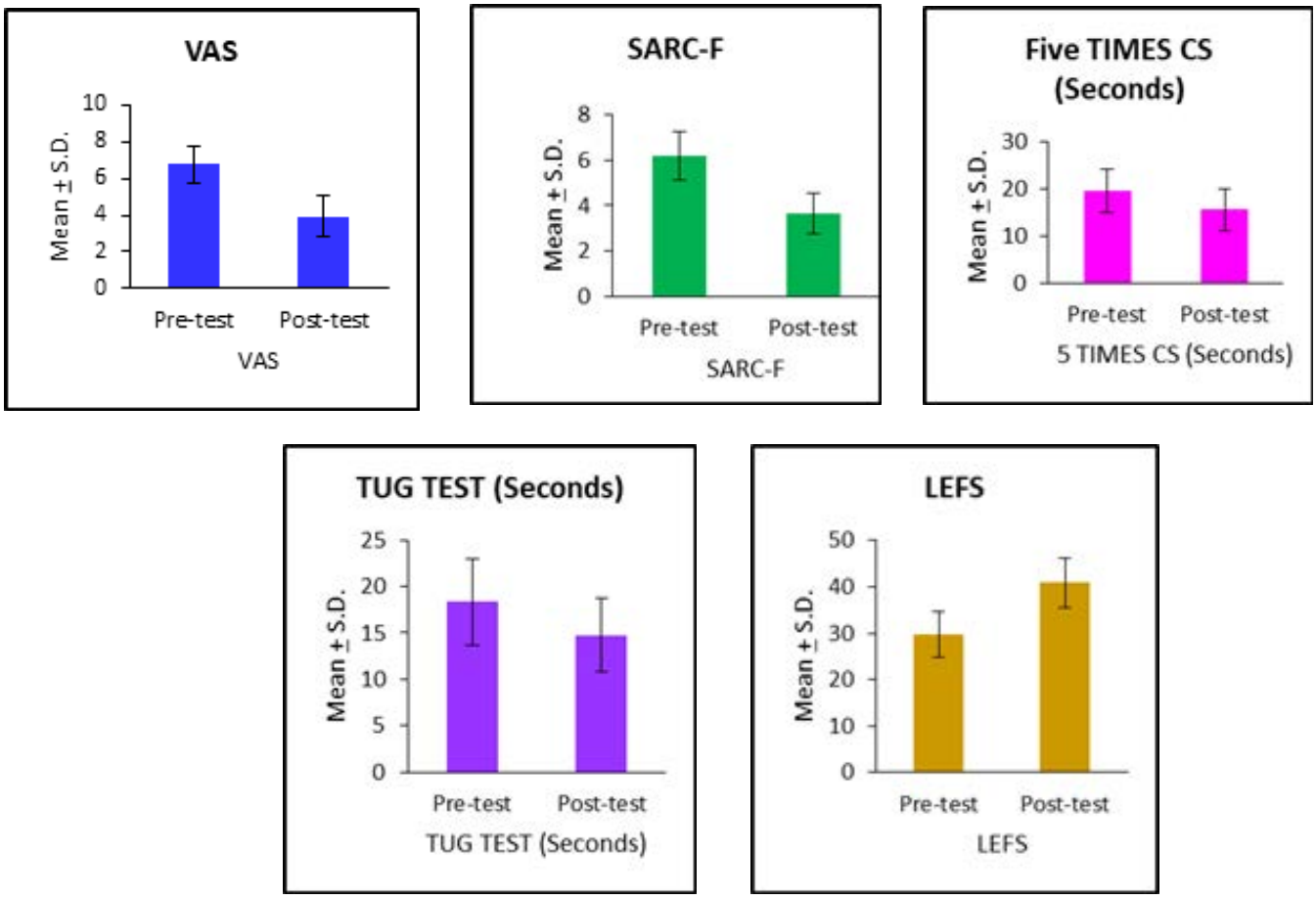


Table 5. SARC-F, 5 TIMES CS (seconds), TUG Test (seconds) and LEFS between groups pre and post

Effectiveness (Pre-Post)		Mean	S.D.	"t"	p value
VAS	Group A	2.91	0.83	0.60	0.552
	Group B	2.72	1.02		
SARC-F	Group A	2.82	1.13	1.43	0.162
	Group B	2.28	1.13		
5 TIMES CS	Group A	3.89	1.85	-0.18	0.859
	Group B	4.04	2.94		
TUG TEST	Group A	3.80	2.25	0.55	0.587
	Group B	3.33	2.80		
LEFS	Group A	-11.24	4.79	-0.23	0.822
	Group B	-10.83	5.61		

("t" = Independent sample "t" test)

4.35 kg/m². These statistics provide a summary of the age and BMI distribution within the study sample.

The Paired "t" test was used to compare VAS, SARC-F, 5 TIMES CS (seconds), TUG Test (seconds) and LEFS within the groups. There was a difference ($p < 0.05$) in VAS, SARC-F, 5 TIMES CS (seconds), TUG Test (seconds) and LEFS within Group - A as well as Group - B. (Table 4)

The Independent sample "t" test was used to compare the effectiveness (pre-post) in VAS, SARC-F, 5 TIMES CS (seconds), TUG Test (seconds) and LEFS between the groups. There was no difference ($p > 0.05$) in the effectiveness in VAS, SARC-F, 5 TIMES CS (seconds), TUG Test (seconds) as well as LEFS between the groups A and B (Table 5).

7. Discussion

The study aimed to compare the effectiveness of closed kinetic chain exercises and resistance training in individuals with knee Osteoarthritis and Sarcopenia, using outcome measures such as SARC-F, VAS, Timed up and Go test, 5 times Sit-to-stand test, and lower extremity function scale.

As shown in Table 3, the descriptive statistics for the sample of 36 individuals aged 64 to 79 years indicate a mean age of 71.14 years with a standard deviation of 3.94 years. The BMI of participants ranges from 19.2 to 37.8 kg/m², with a mean of 25.61 kg/m² and a standard deviation

of 4.35 kg/m². These statistics provide a clear picture of the age and BMI distribution, highlighting the central tendency and variability in this group of older adults

To evaluate the effects of closed kinetic chain exercises and resistance training in individuals with knee Osteoarthritis and Sarcopenia, Table 4 presents the pre-test and post-test results for various measures in Group A and Group B. The data demonstrate significant differences between the groups, with Group A consistently showing higher mean values for VAS (Visual Analog Scale), SARC-F (SARC-Frailty score), 5 Times CS (Time to complete 5 Chair stands), TUG test (Timed up and Go test), and LEFS (Lower Extremity Functional Scale) both before and after the intervention. The statistical significance, indicated by low p-values (< 0.001), emphasizes the strength and reliability of these findings.

Supporting these findings, a study by Krupa *et al*., emphasizes the significant physiological benefits of kinetic-chain exercises for individuals with knee Osteoarthritis, including pain reduction and improved physical function[3]. This research highlights the broader advantages of tailored exercise programs, which not only manage symptoms but also promote overall health improvements in Osteoarthritis patients.

The findings from Zhao *et al*., also align with the physiological benefits of resistance training interventions, showing improvements in pain management, reduction in frailty, enhanced physical performance, and greater functional independence in elderly individuals with Sarcopenia[6]. These results emphasize the importance of structured exercise programs designed to boost muscle strength and overall physical function in aging populations.

To compare the effects of closed kinetic chain exercises and resistance training on pain in individuals with knee Osteoarthritis and Sarcopenia, Table 5 offers key insights. The comparison between Group A and Group B across various effectiveness measures highlights the outcomes of these distinct intervention strategies, particularly in the management of Sarcopenia and knee Osteoarthritis.

These findings are supported by Hurst *et al*., who emphasize the critical role of resistance exercises in addressing Sarcopenia, a condition characterized by age-related muscle loss[16]. Their study highlights the importance of tailored exercise prescriptions to reduce frailty and improve muscle strength in older adults. In contrast, Wei Hui Ng *et al*., examined the effects of open versus closed kinetic chain exercises on pain perception and biomechanics in individuals with knee Osteoarthritis, underscoring the role of exercise in pain management and enhancing lower limb function[14].

The findings from both studies align with the outcomes observed in Group A and Group B. While both groups showed reductions in pain perception (measured by VAS) after the intervention, the differences were not statistically significant (p = 0.552). This mirrors the results of Ng *et al*., who found that both open and closed kinetic chain exercises effectively manage pain, highlighting the flexibility of exercise interventions in pain management.

Similarly, improvements in physical performance such as the 5 times Chair stand (5 times CS) and Timed Up and Go (TUG) tests were observed in both groups showed no significant between-group differences were found (p = 0.859 and p = 0.587, respectively). These results are consistent with the broader goals of both studies, which aimed to enhance biomechanical outcomes through targeted exercise regimens, despite variations in methodologies and patient populations.

LEFS results indicated slight declines in functional abilities in both groups post-intervention, with no significant differences (p = 0.822). This highlights the complexity of evaluating functional outcomes in knee Osteoarthritis, as Wei Hui Ng *et al*., also found that factors beyond exercise type can influence overall functional improvements.

Randomization and blinding are crucial for minimizing bias in clinical trials. In this study, the use of the alternate allocation method and blinding of outcome assessors and data analysts helped ensure that the results were not influenced by preconceived expectations, enhancing the reliability of the findings. High participant adherence (90% attendance) and the use of intent-to-treat analysis strengthened the reliability of the study results by minimizing bias and accounting for dropouts, ensuring a more accurate representation of the intervention's impact.

While both groups demonstrated improvements, no statistically significant differences were seen in pain reduction or physical and functional outcomes between the groups. However, clinically meaningful improvements were observed in the resistance training group for VAS, SARC-F, TUG, and LEFS measures.

8. Clinical Implications

The significant improvements observed in both Group A (Closed Kinetic Chain Exercise) and Group B (Resistance

Training Exercise) suggest that incorporating these exercises could be highly beneficial for patients with knee Osteoarthritis and Sarcopenia. Physical therapists should consider integrating these exercise regimens into rehabilitation programs to enhance physical functioning. This includes designing progressively challenging exercise plans that increase in intensity and precision, ensuring long-term benefits for patients.

In this study, structured and tailored exercise programs were implemented for both Group A (Closed Kinetic Chain) and Group B (Resistance Training), leading to better patient outcomes. The regimens were customized based on pre-test results and individual physical needs, allowing for appropriate progression in strength and mobility. Such personalized exercise interventions can significantly improve patient health and effectively manage symptoms of knee Osteoarthritis and Sarcopenia.

9. Limitation of the Study

1. **Small sample size**: With only 36 participants, the findings may have limited generalizability, and a larger sample would provide more robust and widely applicable results.
2. **Short duration of intervention**: The six-week intervention period may not be sufficient to determine long-term effects on physical performance, muscle strength, and functional outcomes. Extended follow-up would be needed to assess sustainability.
3. **Lack of control group**: As a quasi-experimental design without a control group, the study may not account for all external factors that could influence outcomes, limiting its capacity to establish a strong causal relationship.
4. **Single geographic location**: Data was collected from clinics in Bangalore, which may limit the applicability of the findings to broader or different populations.

10. Conclusion

In conclusion, this study highlights the effectiveness of structured and tailored exercise programs for individuals with knee Osteoarthritis and Sarcopenia. Both closed kinetic chain exercises and resistance training demonstrated significant improvements in pain management and physical functioning among participants. Despite no statistically significant differences between the groups, clinically meaningful benefits were observed, particularly in the resistance training group. These findings underscore the importance of integrating such exercise regimens into rehabilitation practices, as they can enhance overall patient outcomes and promote long-term health benefits. Physical therapists should consider these evidence-based interventions to optimize the management of knee Osteoarthritis and Sarcopenia in their patients.

11. Ethical Approval

Ethical clearance has been obtained by the College of Physiotherapy, School of Health Sciences, Dayananda Sagar University. Ramanagara, Karnataka.

12. Acknowledgement

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14. Annexure

Figures: GROUP A-CLOSED KINETIC CHAIN EXERCISE



Fig-1: Standing terminal extension



Fig-2: Wall slide exercise



Fig-3: Step-up forward



Fig-4: Step-up side

GROUP B- RESISTANCE TRAINING EXERCISE



Fig-5: Leg press

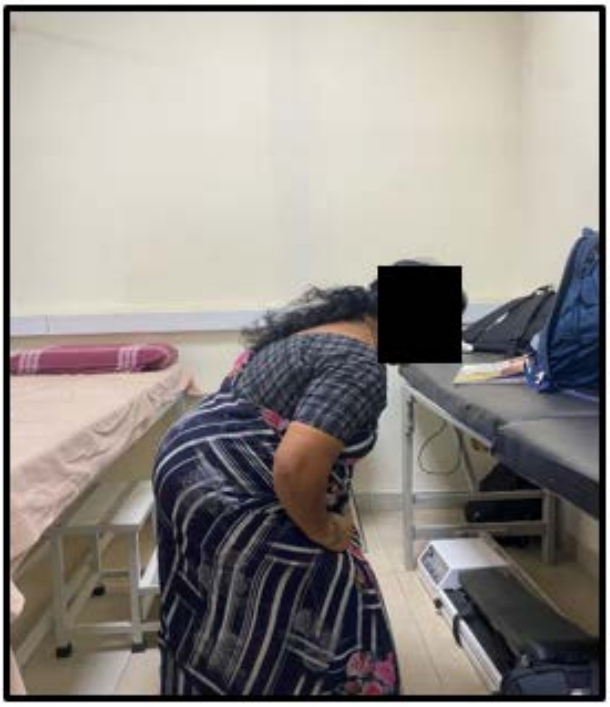


Fig-7: Mini Squat



Fig-6: Leg curl

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