The effect of open kinetic chain and closed kinetic chain exercises on dynamic balance and health status in elderly patients with osteoarthritis

El efecto de los ejercicios de cadena cinética abierta y cerrada sobre el equilibrio dinámico y el estado de salud en pacientes ancianos con osteoartritis

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Abstract

Background: Knee osteoarthritis is one of the most common musculoskeletal problems in the elderly, characterized by pain, stiffness, and decreased joint function, all of which negatively affect quality of life.
Objective: To examine the effect of CKC and OKC exercises on dynamic balance and health status among elderly patients with knee osteoarthritis.
Methods: This study employed a quasi-experimental design with a pretest-posttest two-group approach. The sample consisted of 30 elderly individuals aged ≥60 years with a medical diagnosis of knee osteoarthritis, selected using purposive sampling. Respondents were divided into two groups: 15 participants performed CKC exercises and 15 participants performed OKC exercises for two weeks with a frequency of three sessions per week. The Western Ontario and McMaster Osteoarthritis Index (WOMAC) was used to assess health status, and the Time Up and Go Test (TUG) was used to assess dynamic balance. Data were analyzed using paired t-tests with SPSS software.
Results: There was a significant reduction in WOMAC scores in both the CKC group (38.47 ± 8.16 to 32.60 ± 9.43; $p < 0.001$) and the OKC group (37.53 ± 7.97 to 34.40 ± 8.40; $p < 0.001$). TUG performance also improved significantly in the CKC group (12.80 ± 1.08 to 11.20 ± 1.47; $p < 0.001$) and the OKC group (12.80 ± 1.21 to 11.27 ± 1.28; $p < 0.001$). Overall, improvements in health status were greater in the CKC group compared to the OKC group.
Conclusion: Both CKC and OKC exercises are effective in improving dynamic balance and health status among elderly patients with knee osteoarthritis. CKC exercises tend to provide greater benefits in overall functional improvement

Keywords

Osteoarthritis; elderly; closed kinetic chain; open kinetic chain; dynamic balance.

Resumen

Antecedentes: La artrosis de rodilla es uno de los problemas musculoesqueléticos más comunes en las personas mayores, caracterizada por dolor, rigidez y disminución de la función articular, lo que afecta negativamente la calidad de vida.
Objetivo: Examinar el efecto de los ejercicios en cadena cinética cerrada (CKC) y cadena cinética abierta (OKC) sobre el equilibrio dinámico y el estado de salud en pacientes mayores con artrosis de rodilla.
Métodos: Este estudio empleó un diseño cuasi-experimental con un enfoque de pretest-postest en dos grupos. La muestra estuvo compuesta por 30 adultos mayores de ≥60 años con diagnóstico médico de artrosis de rodilla, seleccionados mediante muestreo intencional. Los participantes se dividieron en dos grupos: 15 realizaron ejercicios CKC y 15 realizaron ejercicios OKC durante dos semanas con una frecuencia de tres sesiones por semana. El índice de osteoartritis de Western Ontario y McMaster (WOMAC) se utilizó para evaluar el estado de salud, y la prueba Time Up and Go (TUG) se empleó para evaluar el equilibrio dinámico. Los datos se analizaron mediante pruebas t pareadas utilizando el software SPSS.
Resultados: Se observó una reducción significativa en los puntajes WOMAC tanto en el grupo CKC (de 38.47 ± 8.16 a 32.60 ± 9.43; $p < 0.001$) como en el grupo OKC (de 37.53 ± 7.97 a 34.40 ± 8.40; $p < 0.001$). El desempeño en la prueba TUG también mejoró significativamente en el grupo CKC (de 12.80 ± 1.08 a 11.20 ± 1.47; $p < 0.001$) y en el grupo OKC (de 12.80 ± 1.21 a 11.27 ± 1.28; $p < 0.001$). En general, las mejoras en el estado de salud fueron mayores en el grupo CKC en comparación con el grupo OKC.
Conclusión: Tanto los ejercicios CKC como OKC son efectivos para mejorar el equilibrio dinámico y el estado de salud en pacientes mayores con artrosis de rodilla. Los ejercicios CKC tienden a proporcionar mayores beneficios en la mejora funcional general..

Palabras clave

Artrosis; personas mayores; cadena cinética cerrada; cadena cinética abierta; equilibrio dinámico.

Introduction

Older adults are a population group that is highly vulnerable to various health problems due to the aging process (Abdelstar, 2024; Dewi et al., 2023). Physiological changes such as reduced muscle mass (sarcopenia), decreased bone density, and limited joint range of motion make them more susceptible to musculoskeletal disorders. Psychologically, these physical limitations may lead to feelings of helplessness, anxiety, and even depression. From a social perspective, many older adults also face reduced roles within their families and communities, leading some to reside in social institutions for support (Nahayatbin et al., 2018). These conditions make osteoarthritis one of the most common degenerative diseases in this group, with significant impacts on independence and quality of life (An et al., 2023).

Osteoarthritis is among the most prevalent degenerative diseases experienced by older adults worldwide, including in Indonesia (Ahmed et al., 2023). It is characterized by progressive damage to articular cartilage, resulting in pain, stiffness, and impaired joint function (Kim & Yoo, 2017). Global data indicate that the prevalence of osteoarthritis in individuals over 40 years of age reaches 22.9%, while in Indonesia the prevalence increases sharply from 30% in those aged 40–60 years to 65% in those over 61 years. In Jambi Province, the prevalence of joint diseases diagnosed in individuals aged ≥15 years is reported at 8.9% (Kemenkes, 2023). These figures highlight that osteoarthritis is not only a global health issue but also a public health challenge at the local level, particularly for older adults with limitations in daily activities (Fadil et al., 2025; Nahayatbin et al., 2018).

Older adults with osteoarthritis not only experience joint pain but also suffer from decreased muscle strength and impaired balance, both of which negatively affect quality of life (Adegoke et al., 2019). Impaired dynamic balance increases the risk of falls, which may lead to disability or even mortality. Unfortunately, in practice many older adults rely solely on symptomatic treatments such as analgesics or traditional massage oils, without engaging in structured physical exercise to maintain musculoskeletal function (Awadh et al., 2025). For instance, residents of the Tresna Werdha Social Institution (PSTW) Budi Luhur Jambi often report joint pain, stiffness, and difficulty walking, but they have not received specific training to improve muscle strength and body balance. This highlights a gap between the need for appropriate interventions and current practices in the field.

Several previous studies have investigated the effectiveness of physical exercise for osteoarthritis, including stretching, conventional therapy, and Pilates-based exercise. The results are promising, showing reductions in pain and improvements in joint function (Hasim & Wijianto, 2019). However, debate remains regarding the most effective type of exercise to improve dynamic balance and health status in osteoarthritis patients (Surya, 2024). Open Kinetic Chain (OKC) exercises are considered effective for strengthening the quadriceps, but they involve less synergistic muscle activation. In contrast, Closed Kinetic Chain (CKC) exercises are more effective in activating the quadriceps and enhancing joint stability by engaging multiple muscle groups simultaneously. Nonetheless, few studies have directly compared the effectiveness of these two exercise types in older adults with osteoarthritis, particularly in Indonesia (Wakhid & Fis, 2023).

This research gap underscores the importance of studies providing empirical evidence on the effectiveness of OKC and CKC exercises in older adults with osteoarthritis. Older adults are a vulnerable group whose quality of life depends greatly on maintaining physical independence. Simple, low-cost, and self-manageable exercise interventions may serve as effective solutions. Given the high prevalence of osteoarthritis in Indonesia, this study is urgently needed, both as a basis for measurable non-pharmacological therapy and as a foundation for developing structured exercise programs in elderly care facilities (Lin et al., 2007; Sim et al., 2025).

The novelty of this study lies in its comparative approach that directly examines and contrasts the effectiveness of OKC and CKC exercises on dynamic balance and health status in older adults with osteoarthritis. While most previous research has focused on only one type of exercise or compared it with conventional therapy, this study provides head-to-head evidence to determine which is more beneficial. Moreover, the study was conducted in a social institution setting, which is rarely used as a site for physical exercise interventions in older adults, thus offering new contributions to community health services.

This study aims to analyze the effects of Open Kinetic Chain and Closed Kinetic Chain exercises on dynamic balance and health status among elderly individuals with osteoarthritis. Specifically, it seeks to

determine the extent to which each type of exercise can improve balance, reduce functional limitations due to osteoarthritis, and enhance overall health.

Method

This study employed a quasi-experimental design with a non-equivalent control group approach to compare the effects of Open Kinetic Chain (OKC) and Closed Kinetic Chain (CKC) exercises on dynamic balance and health status in older adults with osteoarthritis. The study was conducted at the Tresna Werdha Social Institution (PSTW) Budi Luhur Jambi from April to August 2025. This site was selected because it has a relatively large population of elderly residents, many of whom report joint pain and mobility limitations.

The study population included all elderly residents of PSTW Budi Luhur Jambi with complaints of knee osteoarthritis. Sampling was conducted using purposive sampling based on the following inclusion criteria: aged ≥60 years, having a physician's diagnosis of knee osteoarthritis, able to follow exercise instructions, and willing to participate by signing informed consent. Exclusion criteria were older adults with cognitive impairment, severe visual or hearing impairments, or comorbid conditions limiting mobility such as stroke or fractures. A total of 30 respondents met the criteria and were proportionally assigned into two groups: 15 participants in the OKC group and 15 in the CKC group.

Before the intervention, all participants completed pre-tests, which included the Timed Up and Go (TUG) test to measure dynamic balance and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) to assess health status, covering aspects of pain, stiffness, and physical function. The interventions were carried out over two weeks with a frequency of three sessions per week, guided by an instructor using audio-visual media to ensure correct movement execution.

In the OKC group, the standard operating procedure (SOP) included three main exercises: short arc terminal extension, straight leg raise, and hamstring curls. All exercises were performed on a yoga mat with towel support as needed. Each session began with a 5-minute warm-up (e.g., stretching), followed by the main exercise consisting of 10–15 repetitions per movement for 2–3 sets depending on participant capacity, and concluded with simple cool-downs such as deep breathing and stretching (Glass et al., 2010; Witvrouw et al., 2004). The boundary (BAT) for this group was defined as discontinuing exercise if participants reported pain greater than 5 on the Numeric Rating Scale (NRS), excessive fatigue, or inability to maintain balance while seated or lying down.

In the CKC group, the SOP involved step-up and step-down exercises using an exercise stepper. Each session began with a 5-minute warm-up (light stretching), followed by step-up and step-down exercises performed alternately with each leg, 10–15 repetitions per set for 2–3 sets depending on tolerance. Instructors supervised all movements to minimize the risk of falls. Cool-down included lower limb stretching and deep breathing (Ellenbecker & Davies, 2001; Fitzgerald, 1997). The BAT for this group included knee pain exceeding 5 on the NRS, heart rate exceeding 65% of maximum age-predicted heart rate, or signs of fatigue such as severe shortness of breath and limb weakness.

After the intervention period, all participants underwent post-tests using the same instruments (TUG and WOMAC) to evaluate changes in dynamic balance and health status. Data were analyzed quantitatively using SPSS version 25. Univariate analysis was applied to describe respondent characteristics, while bivariate analysis used paired sample t-tests to compare pre- and post-test results within each group and independent sample t-tests to compare results between the OKC and CKC groups. A significance level of $p < 0.05$ was applied.

This study was approved by the Health Research Ethics Committee of Poltekkes Kemenkes Jambi (No: LB.02.06/2/888/2025). All participants received explanations regarding the objectives, benefits, procedures, and minimal risks of the study and provided written informed consent prior to participation. Participant confidentiality was maintained, and they had the right to withdraw at any time without penalty.

Results

Table 1 shows mean age of participants in the CKC group was 68.7 ± 5.1 years, while in the OKC group it was 69.3 ± 4.8 years, indicating that both groups had a relatively similar age range. In terms of sex, respondents were predominantly female, accounting for 60% in the CKC group and 66.7% in the OKC group, with the remainder being male. Regarding occupation, the majority of respondents in both groups were no longer working or had retired (80% in the CKC group and 86.7% in the OKC group). Only a small proportion of respondents had a background as farmers or laborers (13.3% in CKC and 6.7% in OKC), while the "other" occupation category accounted for 6.7% in each group.

The educational level of respondents tended to be low. In the CKC group, most respondents had completed elementary school (46.7%) or had no formal education (26.7%), with only 6.7% having completed senior high school. A similar pattern was observed in the OKC group, where 40% were elementary school graduates and 33.3% had no formal education, while only 13.3% had completed senior high school. None of the respondents in either group had attended higher education. All respondents in both the CKC and OKC groups (100%) lived in the nursing home, consistent with the study location at PSTW Budi Luhur Jambi. This reflects a similar social condition among respondents, as all were under institutional care.

In terms of clinic visit frequency, the majority of respondents in the CKC group (53.3%) and the OKC group (60%) reported routine visits 1–2 times per month. Meanwhile, 33.3% in the CKC group and 26.7% in the OKC group visited less than once per month. A smaller proportion of respondents, 13.3% in each group, reported clinic visits of three or more times per month.

Table 1. Characteristics of the Study Respondents

Characteristics	CKC Group (n=15)	OKC Group (n=15)
Age (years, Mean ± SD)	68.7 ± 5.1	69.3 ± 4.8
Sex		
Male	6 (40%)	5 (33.3%)
Female	9 (60%)	10 (66.7%)
Occupation		
Retired/Unemployed	12 (80%)	13 (86.7%)
Farmer/Laborer	2 (13.3%)	1 (6.7%)
Others	1 (6.7%)	1 (6.7%)
Education level		
No formal education	4 (26.7%)	5 (33.3%)
Elementary school	7 (46.7%)	6 (40%)
Junior high school	3 (20%)	2 (13.3%)
Senior high school	1 (6.7%)	2 (13.3%)
Higher education	0 (0%)	0 (0%)
Living arrangement		
Living alone	0 (0%)	0 (0%)
With family	0 (0%)	0 (0%)
Nursing home/social care	15 (100%)	15 (100%)
Frequency of clinic visits		
<1 time/month	5 (33.3%)	4 (26.7%)
1–2 times/month	8 (53.3%)	9 (60%)
≥3 times/month	2 (13.3%)	2 (13.3%)

Table 2 shows a significant difference in WOMAC scores between the pretest and posttest in both intervention groups. In the Closed Kinetic Chain (CKC) group, the mean WOMAC score decreased from 38.47 ± 8.16 at pretest to 32.60 ± 9.43 at posttest, with a t-value of 16.76 and $p < 0.001$. This finding indicates that CKC exercises significantly improved the health status of elderly patients with osteoarthritis.

Table 2. Dependent t-test Results of WOMAC Scores in the CKC Group (n = 15)

Variable	Pretest (Mean ± SD)	Posttest (Mean ± SD)	t-value	p value
WOMAC	38,47 ± 8,16	32,60 ± 9,43	16,76	<0,001

Table 3 shows that in the Open Kinetic Chain (OKC) group, the mean WOMAC score decreased from 37.53 ± 7.97 at pretest to 34.40 ± 8.40 at posttest, with a t-value of 16.33 and $p < 0.001$. These results

also confirm that OKC exercises had a positive impact in reducing WOMAC scores and improving the health status of the respondents.

Table 3. Dependent t-test Results of WOMAC Scores in the OKC Group (n = 15)

Variable	Pretest (Mean ± SD)	Posttest (Mean ± SD)	t-value	p value
WOMAC	37,53 ± 7,97	34,40 ± 8,40	16,33	<0,001

Table 4 shows mean TUG time in the CKC group decreased from 12.80 ± 1.08 seconds at pretest to 11.20 ± 1.47 seconds at posttest. The dependent t-test yielded a t-value of 8.41 with $p < 0.001$, indicating that this reduction was statistically significant. Thus, CKC exercises were shown to enhance the speed and efficiency of functional mobility in elderly patients with osteoarthritis, reflecting improvements in dynamic balance and daily movement ability.

Table 4. Dependent t-test Results of TUG Scores in the CKC Group (n = 15)

Variable	Pretest (Mean ± SD)	Posttest (Mean ± SD)	t-value	p value
TUG (sec)	12,80 ± 1,08	11,20 ± 1,47	8,41	<0,001

Table 5 shows in the OKC group, the mean TUG time also decreased from 12.80 ± 1.21 seconds to 11.27 ± 1.28 seconds after the intervention. The dependent t-test showed a t-value of 8.36 with $p < 0.001$, indicating that the reduction was statistically significant. These findings suggest that OKC exercises were effective in improving dynamic balance and functional mobility, although the degree of improvement was slightly lower compared to the CKC group.

Table 5. Dependent t-test Results of TUG Scores in the OKC Group (n = 15)

Variable	Pretest (Mean ± SD)	Posttest (Mean ± SD)	t-value	p value
TUG (sec)	12,80 ± 1,21	11,27 ± 1,28	8,36	<0,001

Table 6 shows that both the Closed Kinetic Chain (CKC) and Open Kinetic Chain (OKC) groups experienced significant improvements in WOMAC scores and TUG performance after the intervention. However, the independent t-test indicated that improvements were greater in the CKC group compared to the OKC group, both in WOMAC ($t = 6.85$; $p < 0.001$) and TUG ($t = 3.46$; $p = 0.0017$). These findings suggest that CKC exercises are more effective than OKC exercises in enhancing health status and functional mobility in older adults with knee osteoarthritis.

Table 6. Comparison of Changes in WOMAC and TUG Scores between CKC and OKC Groups

Variable	CKC Δ (Mean ± SD)	OKC Δ (Mean ± SD)	t-value	p-value
WOMAC	5.87 ± 1.36	3.13 ± 0.74	6.85	0.000000 ($p < 0.001$)
TUG	2.40 ± 0.51	1.60 ± 0.74	3.46	0.0017 ($p < 0.01$)

Discussion

This study demonstrated that both types of exercise interventions, Closed Kinetic Chain (CKC) and Open Kinetic Chain (OKC), significantly improved health status (WOMAC scores) and dynamic balance (TUG) in elderly individuals with osteoarthritis. The greater reduction in WOMAC scores observed in the CKC group compared to the OKC group suggests that CKC exercises were more effective in improving joint function, reducing pain, and enhancing daily activities. Meanwhile, the improvements in TUG time in both groups confirmed that both CKC and OKC were effective in enhancing dynamic balance, although the improvement was slightly more pronounced in the CKC group.

These findings are consistent with the study by Takacs et al., 2017 found that functional exercise programs improved dynamic balance and mobility in the elderly. In addition, Desai et al., 2022 showed that both CKC and OKC effectively reduced pain and improved function, with CKC demonstrating greater benefits in terms of proprioception and joint stability. Thus, the results of the present study strengthen the evidence that exercise interventions represent a relevant non-pharmacological approach for osteoarthritis management.

Physiologically, the mechanisms underlying the improvements seen with CKC and OKC exercises can be explained by several theories. CKC exercises involve simultaneous contraction of major muscle groups (quadriceps, hamstrings, gluteus) through weight-bearing movement patterns (Adegoke et al., 2019; Özüdoğru & Gelecek, 2023). This activity enhances neuromuscular activation, proprioception, and joint compression, which distributes the load on the knee more evenly and reduces pain. Conversely, OKC exercises work more specifically on single muscle groups, particularly the quadriceps, through free joint movements. Although OKC provides less proprioceptive stimulation compared to CKC, it remains effective for strengthening key muscles supporting the knee. Both types of exercise may also improve synovial fluid viscosity, increase local blood circulation, reduce inflammatory mediators, and enhance joint tissue metabolism, thereby alleviating osteoarthritis symptoms (Galiano et al., 2021).

Furthermore, the condition of the elderly themselves plays a crucial role. Aging is associated with sarcopenia (loss of muscle mass), decreased bone density, and reduced sensorimotor function, all of which negatively affect balance (Aprillia et al., 2023). These changes directly impact quality of life by reducing independence, increasing the risk of falls, and limiting social participation. Structured exercise interventions such as CKC and OKC can help mitigate these degenerative effects by enhancing muscle strength, joint stability, and functional capacity. This aligns with the theory of successful aging, which emphasizes the role of physical activity as a protective factor in maintaining quality of life among older adults (Bimantara & Ariyanto, 2024; Thalib & Sunarti, 2021).

It is noteworthy that in this study, a small proportion of elderly participants who received CKC or OKC interventions did not exhibit meaningful improvements in WOMAC scores. Several factors may explain this variation, including differences in the severity of osteoarthritis, the presence of comorbid conditions (such as diabetes mellitus or hypertension that may affect functional capacity), as well as individual motivation and engagement in the exercise program. Psychological factors, such as anxiety about pain or low self-confidence, may also influence exercise response. This finding highlights that although exercise interventions are generally effective, individual responses may vary, underscoring the need for more personalized and integrative approaches in exercise programs for elderly patients with osteoarthritis.

This study confirms that simple and structured exercise interventions can serve as effective non-pharmacological strategies to improve the health of elderly individuals with osteoarthritis. CKC has a distinct advantage in enhancing daily functional performance, making it particularly suitable for older adults with activity limitations. OKC remains beneficial, especially for those with severe mobility restrictions who are unable to perform full weight-bearing activities. Therefore, the choice of exercise should be tailored to the individual's clinical condition.

Study Limitations

This study has several limitations, namely the relatively short duration of the intervention (two weeks), which was insufficient to capture long-term effects, and the small sample size. Therefore, future research is recommended to involve a larger sample size, with at least 30 participants per group, selected randomly, and to include a control group without exercise, as well as a longer intervention period (minimum of 3 months) to strengthen clinical validity.

Conclusions

This study showed that both Closed Kinetic Chain (CKC) and Open Kinetic Chain (OKC) exercises were effective in improving dynamic balance and health status in elderly patients with knee osteoarthritis. Both interventions produced significant reductions in WOMAC scores and improvements in TUG performance after a two-week training program. CKC exercises provided greater improvements in overall health status compared to OKC. However, future studies with a longer intervention duration and a larger sample size are needed to strengthen the clinical evidence.

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References

Abdelstar, A. A. (2024). Open versus closed kinetic chain exercise on quadriceps hamstring ratio and thickness in knee osteoarthritis. *Egyptian Journal of Physical Therapy*, *17*(1), DOI: 10.21608/ejpt.2023.203784.1128.

Adegoke, B. O., Sanya, A. O., Ogunlade, S. O., & Olagbegi, O. M. (2019). The effectiveness of open versus closed kinetic chain exercises on pain, function and range of motion in patients with knee osteoarthritis. *Baltic Journal of Health and Physical Activity*, *11*(3), 5. doi: 10.29359/BJHPA.11.3.05.

Ahmed, F., Hossain, K. M. A., Islam, M. S., Hassan, M. N., Nahid, Z. B. S., Uddin, M. K., Islam, M. W., & Haque, M. O. (2023). The effects of closed kinetic chain exercise on pain and physical function in patients with knee osteoarthritis: a narrative review. *Bulletin of Faculty of Physical Therapy*, *28*(1), 48. https://doi.org/10.1186/s43161-023-00161–00168.

An, J., Son, Y.-W., & Lee, B.-H. (2023). Effect of combined kinematic chain exercise on physical function, balance ability, and gait in patients with total knee arthroplasty: a single-blind randomized controlled trial. *International Journal of Environmental Research and Public Health*, *20*(4), 3524. DOI: 10.3390/ijerph20043524.

Aprillia, T. C. A., Pradita, A., Endaryanto, A. H., & Hargiani, F. X. (2023). Perbandingan Dosis Open Kinetic Chain Terhadap Perubahan Kemampuan Fungsional Pasien Osteoarthritis Genue di Rumah Sakit Perkebunan Jember Klinik. *Jurnal Keperawatan Muhammadiyah*, DOI: https://doi.org/10.30651/jkm.v0i0.16286.

Awadh, J. M., Hummadi, J. N., Nabhan, H. A., Mubder, W. H., & Othman, A. A. (2025). El efecto de un programa de entrenamiento propuesto en el desarrollo de algunas habilidades bio motoras y la mejora del rendimiento de las habilidades de cadena cinética en el suelo y las barras paralelas en gimnasia artística para estudiantes. *Retos*, *65*, 709. DOI: https://doi.org/10.47197/retos.v65.11106.

Bimantara, M. A., & Ariyanto, A. (2024). Perbedaan pengaruh latihan closed kinetic chain dan open kinetic chain terhadap peningkatan kemampuan fungsional pada lansia penderita osteoarthritis knee. *Prosiding Seminar Nasional Penelitian Dan Pengabdian Kepada Masyarakat LPPM Universitas' Aisyiyah Yogyakarta*, *2*, 1181-1187. https://proceeding.unisayogya.ac.id/ind.

Desai, R. R., Damsam, A. R., & Palekar, T. J. (2022). 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. *Journal of Clinical and Diagnostic Research*, *16*, YC05-YC09. DOI:10.7860/JCDR/2022/51079.16766.

Dewi, V., Masyitah, D., & Irmawati, I. (2023). The Effect of Closed Kinetic Chain Exercise on Pain Scale and Range of Joint Movement in Elderly with Osteoarthritis in Work Area Puskesmas Simpang IV Sipin. *Proceeding International Conference Health Polytechnic of Jambi*, *1*, 65-73.DOI: https://doi.org/10.35910/icohpj.v1i0.64.

Ellenbecker, T. S., & Davies, G. J. (2001). *Closed kinetic chain exercise: a comprehensive guide to multiple joint exercise*. Human Kinetics. doi: 10.1016/S0899-3467(07)60039-1.

Fadil, A., Muaidi, Q. I., Alayat, M. S., AlMatrafi, N. A., Subahi, M. S., & Alshehri, M. A. (2025). The Effectiveness of closed kinetic chain exercises in individuals with knee osteoarthritis: A

systematic review and meta-analysis. *PLoS One*, *20*(5), e0322475. DOI: 10.1371/journal.pone.0322475.

Fitzgerald, G. K. (1997). Open versus closed kinetic chain exercise: issues in rehabilitation after anterior cruciate ligament reconstructive surgery. *Physical Therapy*, *77*(12), 1747-1754. DOI: 10.1093/ptj/77.12.1747.

Galiano, C., Floria, P., Muñoz-López, A., & Nuñez, F. J. (2021). La falta de experiencia es una limitación para el rendimiento mecánico en sentadillas cuando se usan dispositivos de inercia rotacional Lack of experience in the use the rotational inertia device is a limitation to mechanical squat performance. *Retos*, *42*, 12. DOI:10.47197/retos.v42i0.85714.

Glass, R., Waddell, J., & Hoogenboom, B. (2010). The effects of open versus closed kinetic chain exercises on patients with ACL deficient or reconstructed knees: a systematic review. *North American Journal of Sports Physical Therapy: NAJSPT*, *5*(2), 74. https://pubmed.ncbi.nlm.nih.gov/21589664/.

Hasim, R. P., & Wijianto, S. (2019). *Penatalaksanaan Closed Kinetic Chain Exercise pada Kasus Osteoarthritis Knee Bilateral di RSUD Ir. Soekarno Sukoharjo*. Universitas Muhammadiyah Surakarta. https://eprints.ums.ac.id/75359/.

Kemenkes. (2023). *Laporan Riskesdas 2023*. April 2024. https://www.badankebijakan.kemkes.go.id/laporan-hasil-survei/

Kim, M.-K., & Yoo, K.-T. (2017). The effects of open and closed kinetic chain exercises on the static and dynamic balance of the ankle joints in young healthy women. *Journal of Physical Therapy Science*, *29*(5), 845–850. https://doi.org/10.1589/jpts.29.845

Lin, D.-H., Lin, Y.-F., Chai, H.-M., Han, Y.-C., & Jan, M.-H. (2007). Comparison of proprioceptive functions between computerized proprioception facilitation exercise and closed kinetic chain exercise in patients with knee osteoarthritis. *Clinical Rheumatology*, *26*(4), 520-528. DOI: 10.1007/s10067-006-0324–0.

Nahayatbin, M., Ghasemi, M., Rahimi, A., Khademi-Kalantari, K., Naimi, S.-S., Tabatabaee, S.-M., & Zarein-Dolab, S. (2018). The effects of routine physiotherapy alone and in combination with either tai chi or closed kinetic chain exercises on knee osteoarthritis: a comparative clinical trial study. *Iranian Red Crescent Medical Journal*, *20*(4), DOI:10.5812/ircmj.62600.

Özüdoğru, A., & Gelecek, N. (2023). Effects of closed and open kinetic chain exercises on pain, muscle strength, function, and quality of life in patients with knee osteoarthritis. *Revista Da Associação Médica Brasileira*, *69*(7), e20230164. DOI: 10.1590/1806-9282.20230164.

Sim, J. A., Kong, K.-S., Kim, M. H., Kim, K. J., & Lee, B. H. (2025). *Comparison of Closed and Open Kinetic Chain Exercises Following Total Knee Arthroplasty in Elderly Women: A Randomized Controlled Trial*. DOI:10.20944/preprints202507.2094.v1.

Surya, D. A. (2024). Beda Pengaruh Pemberian Close Kinetic Chain Dengan Isometric Quadriceps Terhadap Peningkatan Kemampuan Fungsional Osteoartritis Lutut. *Jurnal Nasional Fisioterapi (JURNAFISIO)*, *2*(1), 17-24. https://jurnafisio.com/index.php/JF/article.

Takacs, J., Krowchuk, N. M., Garland, S. J., Carpenter, M. G., & Hunt, M. A. (2017). Dynamic balance training improves physical function in individuals with knee osteoarthritis: a pilot randomized controlled trial. *Archives of Physical Medicine and Rehabilitation*, *98*(8), 1586-1593. DOI: 10.1016/j.apmr.2017.01.029.

Thalib, A. H. S., & Sunarti, S. (2021). Effectiveness of Closed Kinetic Chain Exercise on Increasing Functional Strength in Knee Osteoarthritis Patients. *Jurnal Ilmiah Kesehatan Sandi Husada*, *10*(2), 671-675. doi: 10.1371/journal.pone.0322475.

Wakhid, A., & Fis, W. S. (2023). *Efektivitas Closed Kinetic Chain Exercise Untuk Meningkatkan Aktifitas Fungsional Pada Post Rekontruksi Ligamentum Krusiatum Anterior: A Narrative Review*. Universitas Muhammadiyah Surakarta. https://eprints.ums.ac.id/111769/.

Witvrouw, E., Danneels, L., Van Tiggelen, D., Willems, T. M., & Cambier, D. (2004). Open versus closed kinetic chain exercises in patellofemoral pain: a 5-year prospective randomized study. *The American Journal of Sports Medicine*, *32*(5), 1122-1130. DOI: 10.1177/0363546503262187.

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