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Table Of Contents

Journal Cover	1
Author[s] Statement.....	3
Editorial Team	4
Article information	5
Check this article update (crossmark)	5
Check this article impact	5
Cite this article.....	5
Title page.....	6
Article Title	6
Author information	6
Abstract	6
Article content	7

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Mirror Therapy and Isometric Contraction on Motor Function and Joint Flexibility in Elderly with Stroke

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Abstract

General Background: Stroke is a leading cause of long-term disability among older adults, often resulting in impaired motor function and joint stiffness. **Specific Background:** Mirror therapy and isometric contraction have each been applied in stroke rehabilitation, but evidence regarding their combined use remains limited. **Knowledge Gap:** Research on integrating these interventions for elderly individuals with chronic stroke is scarce. **Aims:** This study evaluated the combined use of mirror therapy and isometric contraction on motor function and joint flexibility in elderly patients with chronic stroke. **Methods:** A one-group pretest–posttest design involved 30 participants receiving 12 intervention sessions over four weeks. **Results:** Motor function improved significantly (FMA-LE: 22.17 ± 6.04 to 25.60 ± 6.02 ; $p < 0.001$), while joint stiffness decreased significantly (MAS: 2.93 ± 0.69 to 2.00 ± 0.87 ; $p < 0.001$). **Novelty:** The study integrates two rehabilitation approaches for elderly stroke patients. **Implications:** The findings support a practical rehabilitation strategy for nursing-led clinical and community care.

Highlights:

- Lower-limb movement capacity increased following the intervention program.
- Muscle tone abnormalities declined after four weeks of treatment.
- The combined rehabilitation protocol is feasible for community nursing practice.

Keywords: Stroke Rehabilitation, Mirror Therapy, Isometric Contraction, Elderly, Motor Function

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Introduction

Stroke is a leading cause of long-term disability worldwide, particularly among the elderly population. In 2019, an estimated 12.2 million new stroke cases and 6.55 million stroke-related deaths were reported globally, with stroke contributing to 143 million disability-adjusted life years (DALYs) [1]. In Indonesia, stroke remains a major cause of disability and dependence, often resulting in prolonged reliance on emotional and physical support from family members [2], [3]. The high incidence of stroke among the elderly is closely related to age-related physiological changes, including reduced vascular elasticity and cardiac function, as well as the presence of comorbid conditions such as hypertension, diabetes mellitus, and atherosclerosis.

Motor dysfunction is one of the most common and disabling consequences of stroke and significantly affects an individual's ability to perform daily activities and maintain independence. Longitudinal studies have demonstrated that post-stroke motor impairments are associated with disrupted brain connectivity patterns, which vary according to the affected hemisphere and evolve over time [4]. Motor impairment is frequently accompanied by decreased joint flexibility, muscle weakness, and abnormal muscle tone, all of which further restrict mobility and reduce quality of life. Upper limb weakness is a prevalent post-stroke condition, with evidence indicating that both muscle weakness and flexor synergy intrusion contribute to impaired motor control [5], [6], [7]. Similarly, lower limb muscle weakness—particularly in the hip and ankle muscles—negatively affects gait performance and balance. Previous studies have shown that strengthening interventions, including individualized isokinetic exercises, can improve functional outcomes and muscle performance in older stroke survivors [8], [9].

Rehabilitation interventions play a critical role in promoting recovery and functional independence among elderly stroke patients. Mirror therapy (MT) is a rehabilitation technique that utilizes visual feedback to create the illusion of normal movement in the affected limb, thereby activating neural pathways involved in motor planning and execution. Numerous studies have reported that mirror therapy can significantly improve upper limb motor function, including movements of the shoulder, elbow, forearm, wrist, and hand [10], [11], [12], [13]. Moreover, mirror therapy has demonstrated effectiveness across both acute and chronic phases of stroke recovery [10], [14], making it a versatile intervention for long-term rehabilitation.

In addition to mirror therapy, isometric contraction exercises are commonly used to improve muscle strength without joint movement and are particularly suitable for elderly stroke patients who may have limited tolerance for dynamic exercises due to spasticity or joint stiffness. Isometric contractions can enhance muscle stability, improve circulation, and help maintain joint range of motion. Previous studies have shown that repetitive isometric training can facilitate motor recovery by increasing maximal force output and reducing force variability in the paretic limb [15]. Furthermore, isometric contraction training has been associated with neuroprotective effects and angiogenesis, which are essential for post-stroke neural recovery [16].

Although mirror therapy and isometric contraction exercises have each demonstrated positive effects on motor recovery, evidence regarding their combined application remains limited, particularly among elderly stroke patients. Most existing studies have focused on single-modality interventions, leaving a gap in understanding the potential synergistic effects of combining visual feedback-based therapy with static muscle strengthening to address both motor control and joint flexibility simultaneously.

The novelty of this study lies in its examination of a combined mirror therapy and isometric contraction intervention as a practical, low-cost, and community-applicable rehabilitation approach specifically designed for elderly individuals with chronic stroke. By integrating two complementary modalities, this study seeks to address complex motor impairments more comprehensively than single-intervention strategies.

Therefore, this study aims to investigate the effect of combining mirror therapy and isometric contraction exercises on motor function and joint flexibility in elderly individuals who have experienced stroke. The findings are expected to contribute evidence-based insights for nursing and rehabilitation practices, particularly in community settings, and to support the development of accessible interventions that enhance functional independence and quality of life among older stroke survivors.

Methods

This study employed a pre-experimental one-group pretest–posttest design to examine the effects of a combined mirror therapy and isometric contraction exercise program on motor function and joint flexibility in elderly individuals with chronic stroke. This design was selected to allow preliminary evaluation of the intervention's effectiveness in a community setting where access to control groups may be limited.

Participants were recruited using purposive sampling from community-based stroke rehabilitation services. The inclusion criteria were: (1) aged 60 years or older, (2) diagnosed with stroke for more than six months, indicating a chronic phase, (3) able to understand and follow verbal instructions, and (4) medically stable with no severe visual impairment, orthopedic disorders, or other neurological conditions affecting lower limb function. All participants provided written informed consent prior to participation.

Demographic data, including age, sex, duration of stroke, and stroke type, were collected using a structured questionnaire.

Motor function of the lower extremities was assessed using the Fugl-Meyer Assessment for Lower Extremity (FMA-LE), a widely used and validated instrument for evaluating motor recovery after stroke. The total FMA-LE score ranges from 0 to 34, with higher scores indicating better motor function. Joint stiffness was assessed using the Modified Ashworth Scale (MAS), which measures muscle tone and spasticity and is commonly applied in stroke rehabilitation research.

The intervention consisted of mirror therapy combined with isometric contraction exercises. Each participant received 12 sessions over a four-week period, with sessions conducted three times per week. Each session lasted approximately 30–45 minutes. During mirror therapy, a mirror was positioned in the sagittal plane to provide visual feedback that created the illusion of symmetrical movement of the lower limbs. Participants were instructed to observe the reflected movements while performing guided tasks. Isometric contraction exercises were performed concurrently, focusing on static contractions of lower limb muscles without joint movement to enhance muscle activation and stability. The intervention was delivered under supervision to ensure safety and correct technique.

Motor function and joint stiffness were assessed at baseline (pretest) and after completion of the intervention (posttest). All assessments were conducted by trained personnel using standardized procedures. Descriptive statistics were used to summarize participant characteristics. Differences between pre- and post-intervention scores were analyzed using paired t-tests, as the data were normally distributed. A p-value of less than 0.05 was considered statistically significant. Pre and post-intervention differences in motor function and joint flexibility were analyzed using either paired t-tests, depending on the normality of the data distribution. A p-value of less than 0.05 was considered statistically significant.

As this study used a one-group design without a control group, the results should be interpreted with caution. The absence of a comparison group limits the ability to attribute observed changes solely to the intervention, as factors such as natural recovery or external influences cannot be fully excluded. This study is intended as a preliminary investigation, and future research using randomized controlled designs is recommended to strengthen causal inference.

Result and Discussion

A. Result

The results in this study included respondent characteristics, pre and post-intervention scores for motor function and joint stiffness, and the effects of intervention on both outcomes.

1. Characteristic of Respondents

Table 1. Characteristic Respondents (n=30)

Characteristic	Category	Frequency (f)	Percentage (%)
Age	young elderly (60–74 years)	30	100%
Sex	Male	13	43%
	Female	17	57%
Duration of Stroke	≤ 6 months	12	40%
	≥ 1 year	18	60%
	> 2 years	0	0%

All respondents were classified as young elderly (60–74 years). More than half of the respondents were women (57%) and had suffered a stroke for one year or more (60%). These characteristics indicate that the respondents were elderly women who were in the early chronic phase of stroke recovery,

2. Motor Function and Joint Stiffness

Table 2. Motor Function and Joint Stiffness Before and After Intervention (n = 30)

Variable		Min–Max	Mean ± SD	Mean Difference	t-value	p-value
Motor Function	Pre	10–31	22.17 ± 6.04			
	Post	11–34	25.60 ± 6.02	-3.43	-11.23	0.000
Joint Stiffness	Pre	2–4	2.93 ± 0.69			
	Post	1–3	2.0 0.87	+0.93	5.64	0.000

*Note: Negative mean difference in motor function indicates improvement; positive mean difference in joint stiffness indicates reduction in stiffness. Paired samples t-test, significance at $p < 0.05$.

The results showed that mirror therapy combined with isometric contraction significantly improved motor function and reduced joint stiffness in elderly stroke patients. There was a statistically significant increase in motor function scores from

a mean of 22.17 (SD = 6.04) before intervention to 25.60 (SD = 6.02) after intervention ($p = 0.000$). The paired t-test yielded a t-value of -11.23, indicating a strong effect of the intervention on motor function. The results of joint stiffness scores also showed a significant decrease from a mean of 2.93 (SD = 0.69) before intervention to 2.00 (SD = 0.87) after intervention ($p = 0.000$), with a t-value of 5.64. These findings suggest that the intervention is effective in improving motor recovery and increasing joint flexibility among the elderly stroke population.

B. Discussion

The findings of this study confirm that combining mirror therapy and isometric contractions can produce meaningful functional benefits in the elderly stroke patients. The observed improvements in motor function scores are consistent with previous studies highlighting the role of visual feedback and mental imagery in facilitating motor recovery. From a nursing perspective, improvements in motor function are clinically important because they are closely related to patients' ability to perform daily activities, maintain mobility, and reduce dependence on caregivers. The reduction in joint stiffness further supports previous evidence suggesting that static muscle contractions enhance neuromuscular control and joint proprioception, both of which are essential for safe and efficient movement in elderly.

Given that all participants were categorized as young elderly (60–74 years), preserved neural plasticity and muscle adaptability in this age group may have contributed to the positive outcomes observed. This finding suggests that even during the chronic phase of stroke, elderly individuals retain the capacity to respond to structured rehabilitation interventions. The improvement achieved after a relatively short intervention period also indicates that a structured regimen of 12 sessions over four weeks may provide a sufficient therapeutic dose to produce observable clinical changes. These results are particularly relevant in community nursing settings, where time-efficient and feasible interventions are needed.

The findings of this study further demonstrate that the combination of mirror therapy and isometric contraction exercises significantly improved motor function and reduced joint stiffness in elderly stroke patients, as indicated by an increase in the mean motor function score from 22.17 to 25.60. These results are supported by evidence showing that mirror therapy, both conventional and technology-based approaches such as virtual reality, can improve upper and lower limb motor function through visual feedback stimulation and brain network reorganization, including activation of the mirror neuron system and enhanced connectivity between motor areas in both hemispheres of the brain [17], [18], [19], [20]. This neural reorganization plays an important role in restoring voluntary movement control, which is often impaired after stroke. Together, these findings support the use of a combined, low-cost, and accessible rehabilitation approach that can be effectively implemented within nursing-led community rehabilitation programs.

Conclusion

The combination of mirror therapy and isometric contraction exercises significantly improved motor function and reduced joint stiffness in elderly with chronic stroke, indicating meaningful functional gains that support mobility and independence in daily activities. This affordable and easy-to-implement intervention is particularly suitable for nursing-led rehabilitation in both clinical and community settings. However, further research using randomized controlled designs with larger samples, longer intervention durations, and follow-up assessments is recommended to strengthen causal evidence and evaluate long-term outcomes across diverse elderly stroke populations.

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References

1. V. L. Feigin et al., "Global, regional, and national burden of stroke and its risk factors, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019," *The Lancet Neurology*, vol. 20, no. 10, pp. 795–820, 2021, doi: 10.1016/S1474-4422(21)00252-0.
2. L. N. B. Sinuhaji, I. Yustina, Nurmaini, R. K. Rochadi, F. Zuska, and Fazidah, "Post-Stroke Elderly Positive Deviance in Bandar Setia Village, Percut Sei Tuan District in 2023," *International Journal of Midwifery Research*, vol. 3, no. 2, pp. 10–18, 2023.
3. A. D. L. Yanti and Y. D. P. Santik, "Risk Factors Associated with Disability among Elderly with Stroke in Indonesia: A Secondary Data Analysis of 2018 National Basic Health Research," *Journal of Public Health for Tropical and Coastal Region*, vol. 5, no. 3, pp. 140–154, 2022, doi: 10.14710/jphtcr.v5i3.15694.
4. L. Dulyan, L. Talozzi, V. Pacella, M. Corbetta, S. J. Forkel, and M. Thiebaut de Schotten, "Longitudinal prediction of motor dysfunction after stroke: A disconnectome study," *Brain Structure and Function*, vol. 227, no. 9, pp. 3085–3098, 2022, doi: 10.1007/s00429-022-02589-5.
5. I. Avni, A. Arac, R. Binyamin-Netser, S. Kramer, J. W. Krakauer, and L. Shmuelof, "The Kinematics of 3D Arm Movements in Sub-Acute Stroke: Impaired Inter-Joint Coordination is Attributable to Both Weakness and Flexor Synergy Intrusion," *Neurorehabilitation and Neural Repair*, 2024, doi: 10.1177/15459683241268535.
6. W. Lv, K. Liu, P. Zhou, F. Huang, and Z. Lu, "Surface EMG analysis of weakness distribution in upper limb muscles post-stroke," *Frontiers in Neurology*, vol. 14, Art. no. 1135564, 2023, doi: 10.3389/fneur.2023.1135564.
7. E. J. Dalton et al., "Prevalence of Arm Weakness, Pre-Stroke Outcomes and Other Post-Stroke Impairments Using Routinely Collected Clinical Data on an Acute Stroke Unit," *Neurorehabilitation and Neural Repair*, vol. 38, no. 2, pp. 1–10, 2024, doi: 10.1177/15459683241268535.

148–160, 2024, doi: 10.1177/15459683241229676.

8. L. Daumas et al., “Effects of Individualized Lower Limb Isokinetic Strengthening in Clinical Rehabilitation of Older Post-Stroke Patients: A Retrospective Study,” *Journal of Rehabilitation Medicine*, vol. 55, 2023, doi: 10.2340/jrm.v55.7803.
9. V. Darak and S. Karthikbabu, “Lower limb motor function and hip muscle weakness in stroke survivors and their relationship with pelvic tilt, weight-bearing asymmetry, and gait speed: A cross-sectional study,” *Current Journal of Neurology*, vol. 19, no. 1, pp. 1–7, 2020, doi: 10.18502/ijnl.v19i1.3275.
10. D. B. C. Gandhi, A. Sterba, H. Khatter, and J. D. Pandian, “Mirror therapy in stroke rehabilitation: Current perspectives,” *Therapeutics and Clinical Risk Management*, vol. 16, pp. 75–85, 2020, doi: 10.2147/TCRM.S206883.
11. I. D. Saragih, R. P. Priyanti, S. O. Batubara, and B.-O. Lee, “Effects of mirror therapy on upper limb motor function of patients with stroke: A systematic review and meta-analysis of randomized controlled trials,” *Palliative Medicine*, vol. 39, no. 1, pp. 24–34, 2025, doi: 10.1177/02692155241299211.
12. W. Limtrakarn, “Mirror Therapy Rehabilitation for Lower Limb of Acute Stroke Patients,” *Applied Science and Engineering Progress*, vol. 15, no. 4, pp. 1–7, 2022, doi: 10.14416/j.asep.2021.05.001.
13. P. Klinkwan, “The Effectiveness of Mirror Therapy to Upper Extremity Rehabilitation in Acute Stroke Patients,” *Applied Science and Engineering Progress*, vol. 15, no. 4, pp. 1–9, 2022, doi: 10.14416/j.asep.2021.05.002.
14. M. E. V., S. I. S., and N. T. E., “Mirror Therapy as a Method of Rehabilitation for Stroke Patients,” *Clinical Medicine (Russian Journal)*, vol. 101, no. 11, pp. 577–581, 2023, doi: 10.30629/0023-2149-2023-101-11-577-581.
15. H. J. Kim, N. Kang, and J. H. Cauraugh, “Transient changes in paretic and non-paretic isometric force control during bimanual submaximal and maximal contractions,” *Journal of NeuroEngineering and Rehabilitation*, vol. 17, no. 1, pp. 1–11, 2020, doi: 10.1186/s12984-020-00693-3.
16. C. Mei and T. Ma, “Roles of Isometric Contraction Training in Promoting Neuroprotection and Angiogenesis After Stroke in Adult Rats,” *Physiological Research*, vol. 71, no. 3, pp. 425–438, 2022, doi: 10.33549/physiolres.934849.
17. D. B. Mekbib et al., “Proactive Motor Functional Recovery Following Immersive Virtual Reality-Based Limb Mirroring Therapy in Patients with Subacute Stroke,” *Neurotherapeutics*, vol. 17, no. 4, pp. 1919–1930, 2020, doi: 10.1007/s13311-020-00882-x.
18. K. Zhang et al., “Mirror therapy reduces excessive variability of motor network in stroke patients: A randomized controlled trial,” *European Journal of Physical and Rehabilitation Medicine*, vol. 61, no. 2, pp. 184–194, 2025, doi: 10.23736/S1973-9087.25.08844-6.
19. H. Y. Madhoun, B. Tan, Y. Feng, Y. Zhou, C. Zhou, and L. Yu, “Task-based mirror therapy enhances the upper limb motor function in subacute stroke patients: A randomized control trial,” *European Journal of Physical and Rehabilitation Medicine*, vol. 56, no. 3, pp. 265–271, 2020, doi: 10.23736/S1973-9087.20.06070-0.
20. H. Y. Hsu, L. C. Kuo, Y. C. Lin, F. C. Su, T. H. Yang, and C. W. Lin, “Effects of a Virtual Reality-Based Mirror Therapy Program on Improving Sensorimotor Function of Hands in Chronic Stroke Patients: A Randomized Controlled Trial,” *Neurorehabilitation and Neural Repair*, vol. 36, no. 6, pp. 335–345, 2022, doi: 10.1177/15459683221081430.
21. K. Zhang et al., “Evidence of mirror therapy for recruitment of ipsilateral motor pathways in stroke recovery: A resting fMRI study,” *Neurotherapeutics*, vol. 21, no. 2, Art. no. e00320, 2024, doi: 10.1016/j.neurot.2024.e00320.
22. L. Ding, K. Zhang, X. Wang, S. Tong, X. Guo, and J. Jia, “Functional reorganization of white matter supporting the transhemispheric mechanism of mirror therapy after stroke: A multimodal MRI study,” *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, vol. 33, pp. 1126–1134, 2025, doi: 10.1109/TNSRE.2025.3549380.
23. W. Cui et al., “Effect and mechanism of mirror therapy on lower limb rehabilitation after ischemic stroke: An fMRI study,” *NeuroRehabilitation*, vol. 51, no. 1, pp. 105–116, 2022, doi: 10.3233/NRE-210307.
24. K. Lin et al., “Clinic- and Home-Based Practice of Mirror Therapy Preceding Augmented Reality in Stroke Rehabilitation: A Crossover Study,” *American Journal of Occupational Therapy*, vol. 79, no. 3, 2025, doi: 10.5014/ajot.2025.050961.
25. D. Gellera, D. M. Nilsen, L. Quinn, S. Van Lew, and C. Bayona, “Home mirror therapy: A randomized controlled pilot study comparing unimanual and bimanual mirror therapy for improved arm and hand function post-stroke,” *Disability and Rehabilitation*, vol. 44, no. 22, pp. 6766–6774, 2022, doi: 10.1080/09638288.2021.1973121.
26. R. Oz, M. Duray, and N. C. Korkmaz, “Effects of scapular exercises on trunk control in patients with acute stroke: A double-blind randomized controlled study,” *Somatosensory & Motor Research*, vol. 41, pp. 272–280, 2023, doi: 10.1080/08990220.2023.2283503.
27. O. Obaseki Chigozie, S. Adodo M., S. Ede Stephen, and A. Elvis I., “Effects of a Four-Week Isometric Exercise Training on Blood Pressure of Hypertensive Stroke Survivors in a Tertiary Health Institution,” *Journal of Hypertension and Management*, vol. 8, no. 1, pp. 1–9, 2022, doi: 10.23937/2474-3690/1510066.
28. W. Guo, J. Gao, Dawazhuoma, X. Mi, Ciwang, and Bianba, “A meta-analysis of randomized controlled trials: Evaluating the efficacy of isokinetic muscle strengthening training in improving knee osteoarthritis outcomes,” *Journal of Orthopaedic Surgery and Research*, vol. 20, no. 1, 2025, doi: 10.1186/s13018-025-05495-8.
29. A. Sengul, M. G. Yavuzer, O. Keles, A. N. Tunali, and D. Tuncer, “Isometric Quadriceps Exercises for Patients with Knee Osteoarthritis: A Randomized Controlled Trial Comparing Knee Joint Position Flexion versus Extension,” *Rehabilitation Research and Practice*, vol. 2022, Art. no. 2690871, 2022, doi: 10.1155/2022/2690871.
30. G. V. Mendonca, J. Carvalho, J. Matos, P. D. G. Santos, B. J. Schoenfeld, and P. Pezarat-Correia, “Combining an Internal Attentional Focus With Mirror Motor Observation Enhances Mechanical Output During Isokinetic Leg-Extension Exercise,” *Journal of Applied Biomechanics*, 2025, doi: 10.1123/jab.2024-0187.
31. O. Kara, B. N. Yardimci, S. Şahin, C. Orhan, A. Livanelioğlu, and A. R. Soylu, “Combined Effects of Mirror Therapy and Exercises on the Upper Extremities in Children with Unilateral Cerebral Palsy: A Randomized Controlled Trial,” *Developmental Neurorehabilitation*, vol. 23, no. 4, pp. 253–264, 2020, doi: 10.1080/17518423.2019.1662853.