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# EFFECTIVENESS OF MIRROR THERAPY ON MUSCLE STRENGTH IMPROVEMENT AND ANXIETY REDUCTION IN STROKE PATIENTS: A QUASI-EXPERIMENTAL STUDY

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## ABSTRACT

**Background:** Stroke is a leading cause of long-term disability. Muscle weakness and anxiety can impede rehabilitation outcomes and diminish quality of life. Mirror therapy is a low-cost intervention increasingly used in stroke rehabilitation; however, evidence regarding its combined effects on motoric and psychological outcomes remains limited.
**Methods:** This quasi-experimental study used a pretest–posttest control group design with 52 subacute stroke patients randomly allocated to an intervention group (n=26) and a control group (n=26). The study was conducted at a hospital-based stroke rehabilitation center in Central Java, Indonesia, from March to June 2025. The intervention group received mirror therapy for 30 minutes per session, five times weekly for four weeks, alongside standard rehabilitation, whereas the control group received standard rehabilitation only. Muscle strength was assessed using the Medical Research Council (MRC) Scale, and anxiety was measured using the Hospital Anxiety and Depression Scale (HADS). Paired and independent t-tests were used for within- and between-group analyses.
**Results:** The intervention group demonstrated significant improvements in muscle strength and significant reductions in anxiety scores across both posttest measurements ($p<0.001$). In contrast, the control group showed no significant changes ($p>0.05$). Post-intervention comparisons indicated significantly higher muscle strength and lower anxiety levels in the intervention group compared to the control group ($p\leq0.001$).
**Conclusion:** Mirror therapy effectively enhances muscle strength and reduces anxiety in subacute stroke patients. Its simplicity, low cost, and non-invasive nature support its integration into stroke rehabilitation programs, particularly in resource-limited settings.
**Keywords:** anxiety, mirror therapy, muscle strength, stroke, rehabilitation

## INTRODUCTION

Stroke remains one of the leading causes of long-term disability worldwide, with significant consequences on both physical and psychological health (Jambi et al., 2024; Kusec et al., 2023). One of the most common complications following stroke is hemiparesis, which results in muscle weakness on one side of the body and interferes with mobility and daily activities. In addition to motor impairment, stroke survivors frequently experience anxiety due to physical limitations and uncertainty about recovery, which can hinder adherence to rehabilitation programs and slow down the healing process (Singh et al., 2018; Suwaryo et al., 2021).

According to the World Health Organization, more than 12 million people worldwide suffer a stroke each year, and approximately half of survivors are left with some form of disability, including motor deficits and psychological distress (Yanti & Santik, 2022). Globally, stroke affects more than 12 million individuals annually, with approximately 50–

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60% of survivors experiencing long-term motor impairment and functional disability (Feigin et al., 2022; Masel et al., 2025; Suman et al., 2024). Anxiety disorders are reported in 20–40% of stroke survivors worldwide, contributing to poor rehabilitation outcomes and reduced quality of life. In Indonesia, stroke remains the second leading cause of death and disability, with national data indicating that more than 55% of stroke survivors experience persistent motor deficits, while anxiety symptoms are reported in approximately 30–35% of patients during the subacute and chronic phases of recovery (Akinyemi et al., 2021; Anwer et al., 2022; Kwakkel et al., 2023). Stroke is the second leading cause of death and disability, with an increasing prevalence among adults aged 45 years and older. These findings highlight the urgent need for comprehensive rehabilitation strategies that address both motor and psychological domains (Adityasiwi et al., 2025; Venketasubramanian et al., 2022).

Mirror therapy is a neurorehabilitation technique that uses visual feedback from a mirror to create the illusion of movement in the affected limb (Bello, 2021; Tofani et al., 2022; Wang et al., 2025). By observing the reflection of the unaffected limb performing movements, patients perceive symmetrical motor activity, which stimulates the motor cortex and facilitates neural reorganization. Previous studies have demonstrated that mirror therapy is effective in improving motor function and muscle strength in stroke patients (Suwaryo et al., 2021; X. Zhang et al., 2021; Y. Zhang et al., 2022). The mechanism involves visual feedback that stimulates the motor cortex, thereby facilitating neuroplasticity and motor recovery (Borowicz et al., 2022; Grooms et al., 2015; Jaafar et al., 2021; Zhuang et al., 2021). However, most of these studies have primarily focused on physical outcomes, while the psychological benefits, particularly in reducing anxiety, remain underexplored. Furthermore, limited evidence exists from low- and middle-income countries, including Indonesia, where the burden of stroke is high and access to comprehensive rehabilitation services is often limited.

The novelty of the present study lies in its holistic evaluation of mirror therapy, assessing not only improvements in muscle strength but also reductions in anxiety among stroke patients. By addressing both motor and psychological aspects simultaneously, this research provides new insights into the broader benefits of mirror therapy in stroke rehabilitation. Therefore, the aim of this study was to evaluate the effectiveness of mirror therapy in improving muscle strength and reducing anxiety among patients with subacute stroke.

Beyond motor recovery, mirror therapy may influence psychological outcomes by enhancing body ownership, self-efficacy, and perceived motor control. Visual illusion and repetitive goal-directed movements have been shown to reduce fear of movement, improve emotional regulation, and decrease anxiety symptoms. Previous studies reported that mirror-based interventions and visually guided motor imagery significantly reduced anxiety and emotional distress in neurological and rehabilitation populations. Untreated motoric impairment and anxiety may reduce patients' motivation, limit participation in rehabilitation, prolong functional dependency, and increase healthcare costs. Therefore, interventions that simultaneously address physical and psychological outcomes are urgently needed in stroke rehabilitation programs.

## RESEARCH METHOD

### Study Design

This study employed a quasi-experimental design with a pretest–posttest control group. The design was chosen to evaluate the effectiveness of mirror therapy on muscle strength improvement and anxiety reduction among stroke patients.

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**Participants**

The study population consisted of patients with subacute stroke (1–6 months after onset) who were undergoing rehabilitation at a hospital stroke center. A total of 52 participants were recruited through purposive sampling, divided equally into intervention (n=26) and control (n=26) groups. The inclusion criteria were: (1) diagnosed with ischemic stroke, (2) experiencing mild to moderate hemiparesis, (3) capable of understanding and following instructions, and (4) willing to participate by signing informed consent. Patients with recurrent stroke, severe cognitive impairment, significant visual disturbances, or severe comorbidities (e.g., heart failure, musculoskeletal disorders) were excluded. Sample size was determined using a two-group comparison formula for quasi-experimental studies, assuming a significance level of 0.05, statistical power of 80%, and a moderate effect size based on previous mirror therapy studies. The minimum required sample size was 24 participants per group; to anticipate potential attrition, 26 participants were recruited for each group.

**Intervention**

Participants in the intervention group received mirror therapy for 30 minutes per session, five times per week, over four consecutive weeks. During the therapy, a mirror was placed in the midsagittal plane, reflecting the movement of the unaffected limb to create the illusion that the affected limb was moving normally. The therapy was conducted under the supervision of a physiotherapist trained in motor recovery and neuroplasticity techniques. The control group received standard rehabilitation therapy according to hospital protocols without the mirror therapy component. The mirror therapy protocol followed standardized procedures described in previous stroke rehabilitation studies, including bilateral upper-limb movements, task-oriented exercises, and repetitive functional motions under visual feedback guidance.

**Instruments**

Muscle strength was assessed using the Medical Research Council (MRC) Scale for Muscle Strength, with scores ranging from 0 (no muscle contraction) to 5 (normal strength). Anxiety level was measured using the Hospital Anxiety and Depression Scale (HADS), specifically the anxiety subscale, consisting of 7 items scored from 0–3 (total score 0–21). A score of 0–7 indicates normal, 8–10 borderline, and 11–21 clinical anxiety. The Medical Research Council (MRC) Scale is a standardized instrument widely used to assess muscle strength in neurological patients. Previous studies have demonstrated excellent inter-rater reliability, with intraclass correlation coefficients (ICC) ranging from 0.90 to 0.96, indicating high reliability and construct validity in stroke populations. Anxiety was measured using the Hospital Anxiety and Depression Scale (HADS). The HADS has been extensively validated across different populations, including stroke patients. The anxiety subscale (HADS-A) has shown good internal consistency, with Cronbach's alpha values ranging from 0.80 to 0.93, and satisfactory construct validity in clinical settings. In the present study, internal consistency reliability testing showed acceptable results, with Cronbach's alpha of 0.88 for the HADS-A, indicating good reliability for measuring anxiety in the study sample.

**Data Analysis**

Data were analyzed using SPSS version 30. Descriptive statistics were used to summarize participant characteristics and study variables. Normality of data distribution was tested with the Shapiro–Wilk test. Normality of data distribution was assessed using the Shapiro–Wilk test. The results indicated that muscle strength and anxiety scores in both

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groups were normally distributed (p>0.05), allowing the use of parametric statistical tests. To evaluate within-group differences (pretest vs. posttest), paired sample t-tests were applied. Between-group differences (intervention vs. control) in posttest outcomes were analyzed using independent sample t-tests. A p-value <0.05 was considered statistically significant.

**Ethical Consideration**

This study was approved by the Health Research Ethics Committee of Universitas Muhammadiyah Gombong (approval number: 107.6/II.3.AU/F/KEPK/VI/2025). All participants received detailed information about the study objectives, procedures, benefits, and risks, and signed informed consent before participation. Confidentiality and anonymity were strictly maintained throughout the research process.

## RESULTS

A total of 52 participants completed the study, with 26 in the intervention group and 26 in the control group. No participants dropped out during the intervention period. All 52 participants completed the study and were included in the final analysis. The majority were male, aged between 40–60 years, and diagnosed with subacute ischemic stroke with mild to moderate hemiparesis. Baseline characteristics between groups were comparable, with no significant differences in age, gender distribution, or pretest scores of muscle strength and anxiety. Paired sample t-tests were used to examine within-group differences between pretest and posttest measurements, while independent sample t-tests were applied to compare posttest outcomes between the intervention and control groups.

Table 1. Characteristics of participants in intervention and control groups (n=52)

| Characteristic | Intervention (n=26) | Control (n=26) | p-value |
|---|---|---|---|
| Age (years, mean ± SD) | 55.3 ± 7.4 | 54.6 ± 6.9 | 0.721 |
| Gender | | | |
| Male | 15 (57.7%) | 14 (53.8%) | 0.781 |
| Female | 11 (42.3%) | 12 (46.2%) | |
| Stroke type | | | |
| Ischemic | 22 (84.6%) | 21 (80.8%) | 0.732 |
| Hemorrhagic | 4 (15.4%) | 5 (19.2%) | |
| Hemiparesis side | | | |
| Right | 14 (53.8%) | 13 (50.0%) | 0.789 |
| Left | 12 (46.2%) | 13 (50.0%) | |
| Baseline muscle strength (MRC) | 2.12 ± 0.48 | 2.19 ± 0.44 | 0.658 |
| Baseline anxiety (HADS-A) | 12.31 ± 2.14 | 11.65 ± 2.11 | 0.341 |

Table 1 shows the baseline characteristics of participants in both groups. The mean age of participants was 55.3 ± 7.4 years in the intervention group and 54.6 ± 6.9 years in the control group. More than half of the participants in both groups were male. The majority of patients had ischemic stroke, with relatively equal distribution of hemiparesis side between right and left. There were no significant differences between groups in demographic variables or baseline pretest scores for muscle strength and anxiety (p>0.05), indicating comparability at the start of the study.

Table 2 presents the paired-samples t-test results comparing pretest and posttest scores across both groups. In the intervention group, there was a significant improvement in muscle strength from pretest to posttest (both PRE1–POST1 and PRE2–POST2, p<0.001). In addition, a significant reduction in anxiety levels was observed (both PRE1–POST1 and

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PRE2–POST2, p<0.001). In contrast, the control group showed no significant changes in muscle strength or anxiety scores (p>0.05).

Table 2. Paired sample t-test results for muscle strength and anxiety

| Variable | Group | Pre Mean ± SD | Post Mean ± SD | Mean Diff | t | p-value |
|---|---|---|---|---|---|---|
| Muscle strength (PRE1–POST1) | Intervention | 2.12 ± 0.48 | 2.81 ± 0.49 | 0.69 | -6.214 | 0.000 |
| | Control | 2.19 ± 0.44 | 2.31 ± 0.45 | 0.12 | -1.022 | 0.317 |
| Muscle strength (PRE2–POST2) | Intervention | 2.35 ± 0.50 | 3.08 ± 0.56 | 0.73 | -6.487 | 0.000 |
| | Control | 2.27 ± 0.48 | 2.38 ± 0.51 | 0.11 | -1.105 | 0.280 |
| Anxiety (PRE1–POST1) | Intervention | 12.31 ± 2.14 | 8.15 ± 2.12 | -4.16 | 7.842 | 0.000 |
| | Control | 11.65 ± 2.11 | 11.19 ± 2.35 | -0.46 | 1.287 | 0.210 |
| Anxiety (PRE2–POST2) | Intervention | 11.92 ± 2.18 | 7.85 ± 2.08 | -4.07 | 7.531 | 0.000 |
| | Control | 11.42 ± 2.09 | 11.08 ± 2.29 | -0.34 | 1.112 | 0.276 |

Independent sample t-tests were conducted to compare posttest scores between intervention and control groups (Table 3). The results indicate that posttest muscle strength scores were significantly higher in the intervent ion group compared to the control group (POST1: 2.81 vs. 2.31, p=0.001; POST2: 3.08 vs. 2.38, p<0.001). Similarly, posttest anxiety scores were significantly lower in the intervention group than in the control group (POST1: 8.15 vs. 11.19, p<0.001; POST2: 7.85 vs. 11.08, p<0.001).

Table 3. Independent sample t-test results for posttest muscle strength and anxiety

| Variable | Intervention (Mean ± SD) | Control (Mean ± SD) | t | p-value |
|---|---|---|---|---|
| Muscle strength POST1 | 2.81 ± 0.49 | 2.31 ± 0.45 | 3.422 | 0.001 |
| Muscle strength POST2 | 3.08 ± 0.56 | 2.38 ± 0.51 | 4.015 | 0.000 |
| Anxiety POST1 | 8.15 ± 2.12 | 11.19 ± 2.35 | -4.762 | 0.000 |
| Anxiety POST2 | 7.85 ± 2.08 | 11.08 ± 2.29 | -5.012 | 0.000 |

Post-intervention outcomes demonstrated that mirror therapy was significantly more effective than standard rehabilitation in improving muscle strength and reducing anxiety levels among stroke patients.

## DISCUSSION

This study demonstrated that mirror therapy was effective in improving muscle strength and reducing anxiety among patients with subacute stroke. Participants who received mirror therapy showed significant increases in muscle strength and significant decreases in anxiety levels, whereas those in the control group who received standard rehabilitation did not show meaningful improvements. Furthermore, between-group analysis confirmed that mirror therapy produced superior outcomes compared to conventional rehabilitation.

The findings related to muscle strength improvement are consistent with previous studies that highlighted the effectiveness of mirror therapy in enhancing motor recovery after stroke. Mirror therapy provides visual feedback that stimulates the motor cortex,

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thereby promoting neuroplasticity and functional reorganization of brain regions responsible for movement control (Gunduz et al., 2021; Suwaryo et al., 2023; K. Zhang et al., 2024). A previous research by Wen et al. (2022) reported that mirror therapy significantly improves motor function, muscle strength, and activities of daily living in stroke survivors. Our findings reinforce this evidence by demonstrating consistent improvements in muscle strength across repeated pretest–posttest measurements.

Beyond the physical benefits, the present study also revealed significant reductions in anxiety among patients who underwent mirror therapy. This aspect has received relatively little attention in prior studies, which mostly focused on motor recovery outcomes. Anxiety is a common psychological complication following stroke, often linked to reduced confidence, dependency, and uncertainty about recovery (Devereux & Berns, 2023; Khazaal et al., 2021). The present results suggest that mirror therapy not only restores motor functions but also fosters psychological well-being (Liao et al., 2020; Pardini et al., 2025). The illusion of movement provided by the mirror may enhance patients' sense of control over their affected limbs, thereby reducing anxiety and improving their engagement with rehabilitation (Brunelli et al., 2023; Manzano-Torra et al., 2024). This finding expands the understanding of mirror therapy as a holistic intervention addressing both physical and psychological dimensions of stroke recovery. The reduction in anxiety observed in this study may be explained by improvements in perceived motor control, reduction of fear-avoidant behavior, and increased confidence during rehabilitation. Visual feedback and task mastery provided by mirror therapy may modulate anxiety-related neural circuits, supporting emotional regulation during recovery.

The novelty of this study lies in its dual evaluation of motor and psychological outcomes. While most prior research in Indonesia and other low- and middle-income countries has focused solely on functional outcomes, this study provides evidence that mirror therapy can simultaneously address psychological distress, particularly anxiety. Such findings are important in contexts where access to mental health support in stroke rehabilitation is limited. By demonstrating that a simple, low-cost intervention like mirror therapy can benefit both domains, this study offers new insights for clinical practice in resource-constrained settings.

Nevertheless, this study has some limitations. The sample size was relatively small and restricted to a single hospital setting, which may limit generalizability. Additionally, the study did not assess long-term outcomes beyond the immediate post-intervention period. Future research should explore the sustained effects of mirror therapy on both motor recovery and psychological health, using larger multicenter trials and diverse patient populations.

In summary, this study confirms the effectiveness of mirror therapy not only for improving muscle strength but also for reducing anxiety in stroke patients. These results highlight the importance of integrating psychological outcomes into stroke rehabilitation research and underscore the potential of mirror therapy as a holistic, cost-effective intervention.

## CONCLUSION

This study demonstrated that mirror therapy is an effective intervention for improving muscle strength and reducing anxiety among patients with subacute stroke. Significant improvements were observed in the intervention group compared with the control group, confirming the dual benefits of mirror therapy in both motor and psychological domains. These findings highlight the importance of adopting a holistic approach in stroke rehabilitation, where physical and mental health outcomes are addressed simultaneously.

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## RECOMMENDATION

The results of this study have several practical implications. First, mirror therapy can be incorporated as a complementary, low-cost, and non-invasive intervention within existing stroke rehabilitation programs. Second, its effectiveness in reducing anxiety suggests that rehabilitation protocols should integrate psychological considerations alongside motor recovery. Third, the intervention is feasible to implement in resource-limited settings, such as in many Indonesian hospitals, making it a practical choice for improving patient outcomes at scale. Finally, the inclusion of mirror therapy may enhance patient motivation and adherence to rehabilitation programs, ultimately leading to better functional recovery and quality of life for stroke survivors.

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