Effectiveness of Mirror Therapy versus Conventional Hand Exercises on Hand Grip Strength in the Geriatric Population: A Comparative Study

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***Abstract*—Background: The geriatric population is expanding rapidly, and age-related decline in hand grip strength contributes to frailty, functional dependence and reduced quality of life. Mirror therapy is a non-invasive neurorehabilitation technique that uses visual feedback to drive cortical reorganisation, but evidence for its effect on grip strength in older adults without neurological pathology is limited.**

Objective: To compare the effectiveness of mirror therapy and conventional hand exercises on hand grip strength in the geriatric population.

Methods: In a comparative pre-test–post-test experimental study, 20 community-dwelling adults aged 60 years and above were recruited by convenience sampling and allocated into two equal groups. Group A (n = 10) received mirror therapy and Group B (n = 10) received conventional hand exercises. Both groups completed 20 supervised sessions over four weeks (five sessions per week, 20 minutes per session). Hand grip strength was measured with a hand-held dynamometer before and after the intervention. Data were analysed using paired and independent t-tests, with significance set at $p < 0.05$.

Results: The groups were comparable at baseline (grip strength, $p = 0.776$). Both improved significantly (Group A: 17.97 ± 2.62 to 23.35 ± 3.06 kg, +30.35%, $t = 13.323$, $p < 0.001$; Group B: 18.28 ± 2.22 to 19.60 ± 2.51 kg, +7.19%, $t = 7.462$, $p < 0.001$). The mean improvement was significantly greater in Group A than in Group B (5.38 ± 1.28 vs 1.32 ± 0.56 kg; $t = 9.209$, $p < 0.001$), with a significant between-group difference at post-test ($t = 2.996$, $p = 0.008$). No adverse events occurred.

Conclusion: Mirror therapy produced significantly greater gains in hand grip strength than conventional hand exercises in older adults. Its simplicity, safety and low cost support its inclusion in geriatric rehabilitation programmes.

***Index Terms*—Mirror therapy; Hand strength; Aged; Neurological rehabilitation; Neuronal plasticity; Sarcopenia**

I. INTRODUCTION

The global population is ageing rapidly. The World Health Organization projects that the number of people aged 60 years and older will more than double, reaching 2.1 billion by 2050 compared with approximately one billion in 2020 [1]. Ageing is accompanied by progressive deterioration of the musculoskeletal, neuromuscular and sensorimotor systems, resulting in reduced muscle mass, strength, coordination and functional ability [2]. Among these changes, the age-related loss of skeletal muscle mass and strength sarcopenia is one of the most clinically important, and the hand and forearm musculature are particularly vulnerable because the hand occupies a disproportionately large area of the primary motor cortex and is highly sensitive to disuse and reduced sensorimotor integration [2].

Hand grip strength has emerged as one of the most robust and clinically validated biomarkers of overall physical health, functional capacity and physiological reserve in older adults. Low grip strength is closely associated with functional disability, falls, fractures, prolonged hospitalisation, frailty and all-cause mortality [3,4]. It underlies most activities of daily living including holding and carrying objects, dressing,

personal hygiene and the safe use of walking aids and values below critical thresholds (approximately 27 kg in men and 16 kg in women) markedly increase the risk of functional dependence [5]. Grip strength also predicts ambulation outcomes in hospitalised older adults [6] and correlates with systemic markers of biological ageing [3].

The decline in grip strength arises from combined peripheral and central changes, including selective atrophy of type II muscle fibres, neuromuscular-junction remodelling, slowed peripheral nerve conduction, reduced motor-unit recruitment and progressive contraction of cortical hand representations [2]. Conventional rehabilitation progressive resistance training, task-oriented hand therapy and functional exercise is effective but is frequently limited in older adults by fatigue, joint pain, exercise intolerance, cognitive impairment and low motivation [2]. There is therefore a need for low-effort, low-cost, non-invasive interventions that remain feasible across the range of geriatric functional abilities.

Mirror therapy is a non-invasive neurorehabilitation technique that follows a fundamentally different route from exercise. First described by Ramachandran for the management of phantom limb pain, it places a mirror in the mid-sagittal plane so that the reflection of the moving, unaffected limb creates a visual illusion of normal, coordinated movement in the affected or weaker limb [8]. This augmented visual feedback is thought to activate the mirror-neuron system and to drive cortical reorganisation through engagement of the premotor cortex, supplementary motor area and primary motor cortex [8]. In older adults, enhanced visual input may partly compensate for degraded proprioceptive feedback, while the technique's minimal physical demand, low cost and suitability for home or community settings make it particularly attractive for this population.

Although mirror therapy is well supported in neurological rehabilitation particularly after stroke [9,10] and increasingly in peripheral upper-limb conditions [11,12], few studies have examined its effect on grip strength in older adults without overt neurological pathology. The present study was therefore designed to compare the effectiveness of mirror therapy and conventional hand exercises on hand grip strength in the geriatric population.

II. MATERIALS AND METHODS

2.1 Study design and setting

This was a comparative, pre-test–post-test experimental study conducted in the physiotherapy outpatient department of a rehabilitation centre over a four-week period. The study was approved by the Institutional Ethics Committee, and all participants provided written informed consent before enrolment. The study was carried out in accordance with the ethical principles of the Declaration of Helsinki.

2.2 Participants

Twenty community-dwelling older adults were recruited by convenience sampling. Eligible participants were aged 60 years or above, of either sex, with reduced hand grip strength, cognitively able to understand and follow instructions, and willing to provide informed consent. Individuals were excluded if they had a recent upper-limb fracture or surgery; a neurological condition affecting upper-limb function (e.g. stroke or Parkinson's disease); severe arthritis or deformity of the hand or wrist; a visual impairment interfering with mirror feedback; or any acute medical illness limiting participation. Participants were allocated into two equal groups of ten: Group A received mirror therapy (experimental) and Group B received conventional hand exercises (control).

2.3 Outcome measure

The primary outcome was hand grip strength, measured in kilograms with a hand-held dynamometer under standardised conditions [7]. Participants were seated comfortably with the elbow flexed to 90° and the forearm in a neutral position. Three trials were recorded and the mean value used. To minimise inter-rater variability, all pre- and post-intervention assessments were performed by the same examiner using an identical testing position.

2.4 Interventions

Both groups completed 20 supervised sessions over four weeks (five sessions per week, 20 minutes per session) delivered by a qualified physiotherapist, with short rest intervals to avoid fatigue.

2.5 Statistical analysis

Data were tabulated and analysed using standard statistical software. Descriptive statistics (mean and

standard deviation) were computed for all variables. Baseline comparability between groups was assessed using the independent-samples t-test for continuous variables and the chi-square test for categorical variables. Within-group changes from pre- to post-intervention were analysed using the paired-samples t-test, and between-group differences in post-test values and mean change scores were analysed using the independent-samples t-test. A p-value < 0.05 was considered statistically significant and < 0.001 highly significant.

III. RESULTS

3.1 Baseline characteristics

The two groups were comparable at baseline (Table 1). Mean age was identical at 72.40 years in both groups (p = 1.000), and mean body mass index did not differ significantly (24.23 ± 2.25 vs 25.70 ± 2.87 kg/m²; p = 0.210). Group A comprised a higher proportion of men (8/10) and Group B a higher proportion of women (7/10), although the association between sex and group did not reach significance (p = 0.064). Right-hand dominance was present in 60% of Group A and 90% of Group B. Critically, baseline grip strength did not differ between groups (17.97 ± 2.62 vs 18.28 ± 2.22 kg; p = 0.776), confirming baseline equivalence.

Table 1. Baseline demographic and clinical characteristics of the two groups

Characteristic	Group A (n = 10)	Group B (n = 10)	p-value
Age (years), mean ± SD	72.40 ± 7.20	72.40 ± 7.50	1.000
Sex (male / female), n	8 / 2	3 / 7	0.064
Dominant hand (right / left), n	6 / 4	9 / 1	
Body mass index (kg/m²), mean ± SD	24.23 ± 2.25	25.70 ± 2.87	0.210
Baseline grip strength (kg), mean ± SD	17.97 ± 2.62	18.28 ± 2.22	0.776

SD, standard deviation. p-values from independent-samples t-test (continuous variables) and chi-square test (sex). NS for all comparisons (p > 0.05).

3.2 Within-group changes in grip strength

Both interventions produced statistically significant within-group improvements in grip strength (Table 2). In Group A, mean grip strength increased from 17.97 ± 2.62 kg to 23.35 ± 3.06 kg a mean gain of 5.38 ± 1.28 kg (30.35%; paired t = 13.323, p < 0.001). In Group B, grip strength increased from 18.28 ± 2.22 kg to 19.60 ± 2.51 kg a mean gain of 1.32 ± 0.56 kg (7.19%; paired t = 7.462, p < 0.001). Pre- and post-intervention mean values for both groups are shown in Figure 1.

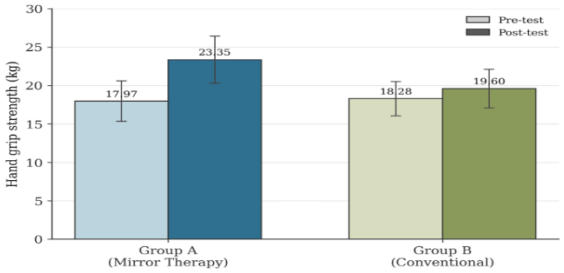

Figure 1. Mean hand grip strength before and after the four-week intervention in Group A (mirror therapy) and Group B (conventional hand exercises). Error bars represent one standard deviation.

3.3 Between-group comparison

At post-test, grip strength was significantly higher in Group A than in Group B (23.35 ± 3.06 vs 19.60 ± 2.51 kg; t = 2.996, p = 0.008). The between-group difference in mean change was highly significant, favouring mirror therapy (5.38 ± 1.28 vs 1.32 ± 0.56 kg; t = 9.209, p < 0.001) an approximately four-fold greater improvement (30.35% vs 7.19%). Every participant in Group A achieved a larger percentage gain than the best-performing participant in Group B (Figure 2), indicating a consistent effect across the group irrespective of age, sex or baseline strength.

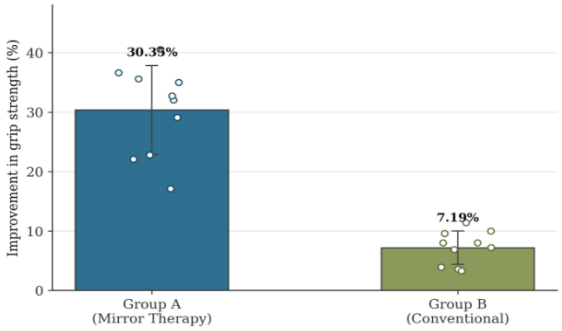

Figure 2. Mean percentage improvement in hand grip strength by group. Open circles show individual participants; error bars represent one standard deviation.

Table 2. Within-group and between-group comparison of hand grip strength

Variable	Group A (Mirror Therapy)	Group B (Conventional)	t	p
Pre-test grip strength (kg)	17.97 ± 2.62	18.28 ± 2.22	0.288	0.776
Post-test grip strength (kg)	23.35 ± 3.06	19.60 ± 2.51	2.996	0.008
Mean change (kg)	5.38 ± 1.28	1.32 ± 0.56	9.209	<0.001
Improvement (%)	30.35 ± 7.47	7.19 ± 2.82		
Within-group change (paired t)	13.323	7.462		<0.001
Sessions attended (/20)	18.2 (91.0%)	18.4 (92.0%)		
Adverse events	None	None		

SD, standard deviation. Between-group comparisons (pre-test, post-test, mean change) and within-group comparisons (paired t) shown. NS = $p > 0.05$; ** $p < 0.01$; *** $p < 0.001$.

3.4 Compliance and safety

Session attendance was high in both groups (91.0% in Group A and 92.0% in Group B), and no adverse events were recorded in either group during the 20-session intervention.

IV. DISCUSSION

This study compared mirror therapy with conventional hand exercises for improving hand grip strength in older adults. Although both interventions produced significant within-group gains, mirror therapy yielded an approximately four-fold greater improvement (30.35% vs 7.19%), and the between-group difference in mean change was highly significant. The consistency of the effect across all participants in the mirror-therapy group argues against a chance or placebo explanation and supports a genuine therapeutic effect.

The superior gains with mirror therapy can be explained by its central, rather than peripheral, mechanism of action. Observing the reflected movement of the stronger hand activates the mirror-neuron system and generates motor-cortical activity corresponding to the weaker hand, even in the absence of overt movement of that hand [8]. Repeated engagement of these circuits is thought to promote use-dependent, Hebbian neuroplasticity, expanding cortical motor representations and increasing corticospinal drive to the hand musculature. In ageing, where proprioceptive and somatosensory feedback are degraded, the largely preserved visual system provides an alternative route to motor-cortex activation, and the augmented visual feedback may also help reverse the maladaptive cortical inhibition that accompanies disuse of the weaker hand.

These findings are consistent with the broader mirror-therapy literature. A Cochrane review concluded that mirror therapy produces small-to-moderate improvements in upper-limb motor function and activities of daily living after stroke, with larger effects at higher treatment intensity [9]. Systematic reviews of neuroimaging studies have shown that mirror visual feedback activates the primary motor cortex, supplementary motor area and premotor cortex bilaterally, providing a neurophysiological basis for these clinical gains [8]. A meta-analysis further reported that combining mirror therapy with complementary techniques maximises upper-limb recovery [10].

Importantly for the present sample, benefit is not confined to neurological populations. A randomised controlled trial in carpal tunnel syndrome found that mirror therapy improved grip strength, wrist range of motion and muscle activity beyond conventional physiotherapy [11], and reviews of musculoskeletal hand and wrist conditions [12] and of peripheral nerve injury [13,14] report similar gains in strength and function. The mechanism is closely related to cross-education, in which unilateral training produces strength gains in the untrained contralateral limb [15]; experimental work has shown that adding mirror visual feedback augments this cross-education producing up to 28% strength transfer by reducing interhemispheric inhibition and increasing motor-cortex excitability [16,17,18]. This provides a direct rationale for grip-strength gains driven by visual feedback rather than by peripheral loading.

The response observed here in older adults is also supported by prior work. Intensively applied mirror therapy has produced clinically meaningful gains in grip strength and motor performance in older post-stroke patients, who tolerated a high-intensity protocol well [19], and studies in elderly and community settings have reported significant improvements in muscle strength and motor impairment following mirror therapy [20,21]. The present results extend this evidence

to older adults with age-related grip weakness in the absence of a defined neurological or musculoskeletal lesion.

The clinical significance of the observed gain is considerable. The mean improvement of 5.38 kg in the mirror-therapy group substantially exceeds the 2–3 kg change generally regarded as clinically meaningful for grip strength in older adults, a magnitude likely to translate into tangible functional benefit for activities of daily living. Mirror therapy is simple, safe and inexpensive; it requires only a standard mirror, imposes minimal physical load on the weaker limb, and can be delivered in clinical, community or home settings. The high adherence (> 90%) and absence of adverse events in both groups support its feasibility and safety in this population, in whom more physically demanding modalities are often poorly tolerated.

4.1 Limitations and future directions

This study has several limitations. The sample was small (n = 20) and drawn from a single centre by convenience sampling, which reduces statistical power and generalisability and introduces the possibility of selection bias. The sexes were unevenly distributed between groups, and the assessor was not blinded to group allocation. The intervention was short, with no long-term follow-up, so the durability of the observed gains is unknown. Larger, adequately powered randomised controlled trials using probability-based sampling, assessor blinding and follow-up at 4 weeks, 3 months and 6 months are needed to confirm these findings and to determine the persistence of the underlying neuroplastic changes.

V. CONCLUSION

Mirror therapy was significantly more effective than conventional hand exercises in improving hand grip strength in older adults, producing an approximately four-fold greater gain over four weeks. Given its sound neurophysiological rationale, simplicity, safety and low cost, mirror therapy warrants consideration as an effective adjunct or first-line intervention within geriatric rehabilitation programmes aimed at improving hand function and preserving functional independence.

Declarations

Ethics approval and consent to participate: The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment.

Consent for publication: Not applicable.

Availability of data: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Conflicts of interest: The authors declare that they have no conflicts of interest.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Author contributions: AY conceived and designed the study, collected and analysed the data, and drafted the manuscript. SB supervised the study and critically revised the manuscript. SS contributed to data interpretation and manuscript revision. All authors read and approved the final manuscript.

Acknowledgements: The authors thank the participants and the staff of the rehabilitation centre for their cooperation during data collection.

REFERENCES

[1] Abbas, K., Z. Hassan, I. Abid, S. M. Gillani, J. A. Jan, et al., "Assessment of sarcopenia and its association with hand grip strength in elderly population," Insights Journal of Health and Rehabilitation, 2024.

[2] Ashlahatul Mar'ah, N., N. Nurhayati, and T. P. Astika Endah, "Effect of mirror therapy intervention on motor impairment improvements in elderly," Jurnal Keperawatan Komprehensif, vol. 9, no. 4, 2023.

[3] Beseler, M. R., C. Rubio, E. Duarte, D. Hervás, M. C. Guevara, M. Giner-Pascual, et al., "Clinical effectiveness of grip strength in predicting ambulation of elderly inpatients," Clinical Interventions in Aging, vol. 9, pp. 1873–1877, 2014.

[4] Chen, Y. H., T. Y. Siow, J. Y. Wang, S. Y. Lin, and Y. H. Chao, "Greater cortical activation and motor recovery following mirror therapy immediately after peripheral nerve repair of the forearm," Neuroscience, vol. 481, pp. 123–133, 2022.

[5] Deconinck, F. J. A., A. R. P. Smorenburg, A. Benham, A. Ledebt, M. G. Feltham, and G. J. P. Savelsbergh, "Reflections on mirror therapy: A systematic review of the effect of mirror visual feedback on the brain," Neurorehabilitation and Neural Repair, vol. 29, no. 4, pp. 349–361, 2015.

[6] Gámez Santiago, A. B., C. M. Martínez Cáceres, and J. J. Hernández-Morante, "Effectiveness of intensively applied mirror therapy in older patients with post-stroke hemiplegia: A preliminary trial," European Neurology, vol. 85, no. 4, pp. 291–299, 2022.

[7] Green, L. A., and D. A. Gabriel, "The effect of unilateral training on contralateral limb strength in young, older, and patient populations: A meta-analysis of cross education," Physical Therapy Reviews, vol. 23, nos. 4–5, pp. 238–249, 2018.

[8] Howatson, G., T. Zult, J. P. Farthing, I. Zijdewind, and T. Hortobágyi, "Mirror training to augment cross-education during resistance training: A hypothesis," Frontiers in Human Neuroscience, vol. 7, Art. no. 396, 2013.

[9] Jati Permata Putri, S., and B. Widiyanto, "Mirror therapy improved muscle strength of the elderly," Advances in Health Sciences Research, 2020.

[10] Kablanoğlu, S., I. Sade, Ç. Çekmece, G. Özdin, L. Buluç, and N. Dursun, "The efficiency of mirror therapy in peripheral nerve injuries," Turkish Journal of Physical Medicine and Rehabilitation, vol. 70, no. 1, pp. 81–89, 2024.

[11] Kemala Sari, N., S. Stepvia, M. F. Ilyas, S. Setiati, K. Harimurti, and I. Fitriana, "Sarcopenia prevention in older adults: Effectiveness and limitations of non-pharmacological interventions," Osteoporosis and Sarcopenia, vol. 11, no. 2, pp. 65–72, 2025.

[12] Kim, D., S. Morikawa, M. Miyawaki, T. Nakagawa, S. Ogawa, and Y. Kase, "Sarcopenia prevention in older adults: Effectiveness and limitations of non-pharmacological interventions," Osteoporosis and Sarcopenia, vol. 11, no. 2, pp. 65–72, 2025.

[13] Luo, Z., Y. Zhou, H. He, S. Lin, R. Zhu, Z. Liu, et al., "Synergistic effect of combined mirror therapy on upper extremity in patients with stroke: A systematic review and meta-analysis," Frontiers in Neurology, vol. 11, Art. no. 155, 2020.

[14] Mirto, M., F. Esposito, F. M. Iaia, and R. Codella, "Cross-education of strength: From theory to practice in contemporary sports rehabilitation—a narrative review and clinical implications," Sports Medicine - Open, vol. 11, Art. no. 56, 2025.

[15] Muñoz-Gómez, E., M. Aguilar-Rodríguez, S. Mollà-Casanova, N. Sempere-Rubio, M. Inglés, and P. Serra-Añó, "A randomized controlled trial on the effectiveness of mirror therapy in improving strength, range of movement and muscle activity in people with carpal tunnel syndrome," Journal of Hand Therapy, vol. 37, no. 4, pp. 534–543, 2024.

[16] Pratt, J., L. Pessanha, M. Narici, C. Boreham, and G. De Vito, "Handgrip strength asymmetry as a new biomarker for sarcopenia and individual sarcopenia signatures," Aging Clinical and Experimental Research, vol. 35, no. 11, pp. 2563–2571, 2023.

[17] Reischl, S., R. Furtado, J. MacDermid, R. Grewal, S. Schabrun, and A. L. Trejos, "Effectiveness of mirror therapy to treat musculoskeletal injuries of the hand and wrist: A systematic review," Journal of Hand Therapy, 2025.

[18] Thieme, H., N. Morkisch, J. Mehrholz, M. Pohl, J. Behrens, B. Borgetto, et al., "Mirror therapy for improving motor function after stroke," Cochrane Database of Systematic Reviews, no. 7, Art. no. CD008449, 2018.

[19] Vermeulen, J., J. C. L. Neyens, M. D. Spreeuwenberg, E. van Rossum, D. J. Hewson, and L. P. de Witte, "Measuring grip strength in older adults: Comparing the Grip-ball with the Jamar dynamometer," Journal of Geriatric Physical Therapy, vol. 38, no. 3, pp. 148–153, 2015.

[20] World Health Organization, "Ageing and health," Geneva, Switzerland: World Health Organization, 2024. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. [Accessed: Jul. 6, 2026].

[21] Zult, T., S. Goodall, K. Thomas, S. Solnik, T. Hortobágyi, and G. Howatson, "Mirror training augments the cross-education of strength and affects inhibitory pathways," Medicine & Science in Sports & Exercise, vol. 48, no. 6, pp. 1001–1013, 2016.