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Effectiveness of Home-Based Mirror Therapy on Enhancing the Upper Limb Sensory-Motor Recovery of Elderly Patients Post-Stroke

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Abstract
Background: Stroke is a major health disorder in the twenty-one century and it's one of the leading causes of elderly death and disability in the upper limbs sensory-motor functions. Mirror therapy is currently used in rehabilitation for stroke elderly patients in either clinical or home-based settings to accelerate upper limb sensory-motor recovery. **Aim:** To evaluate the effectiveness of home-based mirror therapy on enhancing the upper limb sensory-motor recovery of elderly patients post-stroke. **Design:** A pre to post-test experimental design was utilized **Subjects:** A purposive sample of 40 elderly patients post-stroke was recruited **Setting:** The study was conducted in the Rheumatology and Rehabilitation Unit of Mansoura University Hospital and at Elders Homes. **Tools:** An interview schedule sheet and three standardized tools were used **Results:** The mean age of elderly patients post-stroke in both the intervention and comparison group was 65.70±6.11 and 65.35±7.34 years, respectively with no significant difference (p>0.05). A highly statistically significant difference was found in all parameters of the sensory-motor recovery of the upper limb in the intervention group (p<0.01) at pre, and follow-up phases of intervention. Also, highly statistically significant differences were noted between both groups regarding all parameters (p< 0.01) in post-test I and II. **Conclusion:** Home-based mirror therapy is a practical, easy, and cheap nursing intervention that can be used as an adjunct therapy with conventional therapy for recovery of the upper limb in elderly patients post-stroke. **Recommendation:** Mirror therapy should be practiced in either clinical or community settings.

Keywords: Mirror therapy, Sensory-motor recovery, Upper limb, Elderly patients & Stroke.

Introduction
Aging is a stage of progressive functional decline that affects all body systems, and the nervous system is no exception, its changes begin shortly and accumulate over time. Accordingly, neurological deterioration and brain dysfunction resulting from the loss of neurons, and other abnormalities observed in aging brains **(Mattson et al, 2018)**. A stroke is a vascular acute neurological dysfunction caused by blood flow interruption caused by ischemia or hemorrhage to focal areas of the brain **(Lewis et al., 2017**). WHO defined stroke as a "neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours **(Rai et al., 2020)**. It contributes to major morbidity and mortality in developed and developing countries **(Chinnavan et al., 2020)**. With age, stroke incidence increases steeply, so it is one of the leading causes of death and severe disability in most countries. Therefore, stroke is considered a massive epidemic, causing many disabled elderly patients and deaths in forthcoming years **(Sharrief et al., 2019)**.

Aging is considered the most significant non-modifiable risk factor for stroke, doubling every ten years post-age 55. So, the number of incident strokes among the elderly is expected to rise as a result of an increasing number of people aged ≥ 65 years, thus nearly three-quarters of all strokes occur in this age group **(Yousufuddin et al., 2019)**. The number of stroke victims is expected to be 3 times higher in 2030 than today. It is reported that in 1 month one in five will die from stroke, and within one year one in three will die from it. Also, millions of worldwide people suffer from stroke every year; of these, 5 million are permanently disabled while another 5 million lives are claimed by it **(Pu et al, 2023)**. In the United States, stroke is the primary cause of longstanding disability **(Centers for Disease Control & Prevention, 2020)**.

The overall crude prevalence rate of stroke in Egypt is high (963/100,000 people), and there are between 150,000–210,000 new cases of stroke each year.

According to Egypt's official national statistics, stroke accounts for 6.4% of all deaths, particularly among older persons, placing it third in importance behind cardiovascular and gastrointestinal disorders. Although many nations have decreased the number of deaths related to stroke, Egypt has seen a relatively stable rate over the past ten years **(Harikrishnan et al., 2017& Zakaria et al., 2018)**.

A stroke is a medical emergency that can lead to motor, perceptual, sensory, and linguistic impairments, depending on the site, intensity, and how quickly it is diagnosed and treated. Around 88% of older patients post-stroke have impaired motor functions which results in functional limitations and disabilities that limit independence and affect patients' quality of life **(Chinnavan et al., 2020)**. The upper limb is a vital tool for every daily activity. Unfortunately, stroke can affect the motor function of the upper limb in two out of three patients, significantly impacting their motor functionality and effective handling, gripping, and reaching capability required in most activities of daily living. Studies show that approximately 66% of older patients post-stroke suffer from body function disabilities and approximately 75% have limitations in their activities of daily living **(Klinkwan et al., 2021 & Rössler, et al., 2020)**.

Many therapies are available for motor impairment rehabilitation such as; Electrical Stimulation Therapy, Electromyographic (EMG) biofeedback, Constraint-Induced Movement Therapy (CIMT), Sensory-Motor Imagery Training, Robotic-Assisted Rehabilitation, and Mirror Therapy (MT) **(Chinnavan et al., 2020)** Most of these therapies often need expensive machinery that is also difficult to handle, which restricts their widespread usage in clinical practice.

Otherwise, Mirror therapy (MT) is a low-cost, safe, useful, and simple intervention; Ramachandran and colleagues (1995) first developed it to treat phantom limb pain syndrome after arm amputation **(Guémann et al, 2023)**.

It is currently used in rehabilitation for stroke elderly patients, to alleviate sensory-motor deficits and to hasten the affected limb functional rehabilitation **(Dave, 2020)**.

Mirror therapy is applied with a mirror positioned in the sagittal plane between the extremities. To trick the brain, by promoting a visual and kinesthetic illusion, the patient performs movements with the normal limb that are reflected in the mirror and interpreted by the brain as performed by the affected limb. By activating the mirror-neuron system (MNS) and the corticospinal tract, MT accelerates recovery of hemiparesis and promotes cortical reorganization, resulting in functional and motor improvements. So, mirror therapy has thus been shown to be a feasible and effective proven strategy for motor rehabilitation post-stroke as it positively affects movement execution and control **(Jaafar et al, 2021)**. Therefore, this study aimed to evaluate mirror therapy's effectiveness on improving motor function for elderly stroke patients, providing data for gerontological nurses to utilize mirror therapy in different settings.

Significance of the study

One of the most common and unfavorable effects of strokes is upper limb hemiparesis. It has been reported that hemiparesis affects up to 85% of stroke patients and 55%-75% of them still have upper extremity function limitations **(Dave, 2020)**. Thus; this study presents a promising and convenient rehabilitation approach for elderly stroke patients struggling with upper limb limitations. By demonstrating the effectiveness of home-based mirror therapy in improving both sensory and motor function, this research offers a readily accessible treatment option, especially relevant for those facing difficulties in attending traditional therapy due to mobility or transportation constraints **(Jaafar et al, 2021)**.

The home-based approach empowers patients to actively participate in their recovery, potentially significantly improving their quality of life. Furthermore, the study sheds light on the underlying neural mechanisms of mirror therapy, further solidifying its position as a valuable tool in stroke rehabilitation **(Sharrief et al., 2019)**.

The study aimed to evaluate the effectiveness of home-based mirror therapy on enhancing the upper limb sensory-motor recovery of elderly patients post-stroke.

Specific objectives:

1. Assess the upper limb sensory-motor functions of elderly patients post-stroke.
2. Determine the effect of home-based mirror therapy on enhancing the upper limb sensory-motor functions of elderly patients post-stroke.

Research hypothesis:

It was hypothesized that:

Home-based mirror therapy will improve upper-limb sensory-motor recovery of elderly patients post-stroke.

Subjects and Method

Design:

The study was conducted using an experimental pre-post-research design.

Setting:

The study was carried out at Mansoura University Hospital's Rheumatology and Rehabilitation Unit as well as at the studied elders' homes through home visits. Mansoura University Hospital belongs to the Ministry of Higher Education and serves the citizens of Mansoura City and its surrounding villages in the El-Dakahlia Governorate. The Rheumatology and Rehabilitation Unit renders inpatients and outpatient services. It operates from 9 a.m. to 2 p.m. on all weekdays except for Friday.

Participants: Calculation of sample size and sampling procedure

Inclusion criteria:

The study involved a purposive sample of 40 elderly patients aged 60 years or older of both genders, who had no or mild cognitive impairment (≥ 24 on the Saint Louis University Mental Status Examination), with the first stroke episode in less than a year, in stage III or IV (on the Brunnstrom motor recovery scale), with one-sided upper extremity motor impairment, able to communicate, and accepted to participate in this study.

Exclusion criteria:

The elderly patients who had severe perceptual and psychological disorders, significant auditory and visual deficits, Parkinson's disease, spinal cord injury, and a history of contracture or fracture on the stroke-affected extremity were excluded.

Sample size calculation: The sample size was calculated using the mirror therapy effect size (1.0009) from earlier studies **(Armat et al., 2022)**. The minimum sample size was estimated to be 34 (n = 17 for each group) using G*Power 3.1 software and according to the following calculation:

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

After considering a 15% attrition rate into account, the sample size was expanded to 40 (n = 20 in either intervention or comparison group). Finally, using permuted block randomization, the patients were assigned randomly to the intervention (n=20) or comparison (n=20) group. The sample size is estimated using a test comparing two means through the Kane SP Sample Size Calculator. ClinCalc **(Rosner, 2011)**.

Data collection tools:

Four tools were used to collect the necessary data as follows:

Tool I: Socio-Demographic and Clinical Data Structured Interview Schedule of Geriatric Patients post-stroke: This was created by the researchers after reviewing related literature **(Dave et al., 2020 & Chinnavan et al., 2020)**. It is divided into two parts:

- **Part one: Socio-demographic Characteristics of Geriatric Patients post Stroke: -** It included demographic data as; age, gender, marital status, level of education, monthly income, current job, place of residence, and living situation.
- **Part two: Clinical Data of Geriatric Patients Post-Stroke: -** It included clinical data such as; medical diagnosis, stroke duration, dominant side, affected side, and associated illness.

Tool II: Saint Louis University Mental Status (SLUMS) Examination:

Tariq (2006) developed the Saint Louis University Mental Status Examination questionnaire, a simple and quick tool that is extensively used to identify the presence and degree of mental impairment. The questionnaire comprises 11 items with a scoring system based on 30 points. The score for each item depends on the respondent's education level. For those who have completed high school, a normal response ranges from 27 to 30 points, mild neurocognitive disorder ranges from 21 to 26 points, and dementia ranges from 1 to 20 points. For those who have not completed high school, a normal response ranges from 25 to 30 points, mild neurocognitive disorder ranges from 20 to 24 points, and dementia ranges from 1 to 19 points. This tool has been translated into Arabic by **Abdelrahman & El Gaafary (2014)**. It showed excellent reliability in the Egyptian population, with a Cronbach's alpha coefficient of 0.723.

Tool III: Brunnstrom Motor Recovery Scale:

It was developed by the Swedish occupational and physical therapist Signe Brunnstrom in 1960. It is a reliable tool used to evaluate the motor recovery of the upper limb following a stroke according to the degree of spasticity and involuntary movements **(Soofia et al., 2010)**. A patient examination took 5-10 minutes. This tool proposes seven stages of sequential motor recovery post-stroke. **Stage I**: This stage follows the stroke attack where; there is a period of flaccidity in which there is no movement on the affected limb. **Stage II**: At this stage, the recovery begins with the development of spasticity, increased reflexes, and obligatory synergies, which are synergic movement patterns. These obligatory synergies arise as a result of stimulus reactions or limited movement responses and might emerge as the inclusion of all or a portion of the synergic movement pattern. **Stage III:** Spasticity increases at this stage, and obligatory synergies strengthen. The synergy pattern provides the patient with voluntary control, but it may be limited in range. **Stage IV:** where the patient can move more freely and spasticity and synergy diminish. At this stage, the ease of movements goes from challenging to easy. **Stage V:** The patient can now move more easily away from the synergy pattern as the spasticity keeps waning. In this position, the patient can also exhibit more complex movement combinations and single-joint movements. **Stage VI**: At this stage, spasticity has disappeared, allowing for near-normal movement and coordination. **Stage VII**: It is the last recovery stage where; a normal motor function has been re-established.

Tool IV: Fugl- Meyer Assessment tool (FMA). It was created by **Fugl-Meyer et al, 1975**. It was the first quantitative tool for evaluating sensory-motor recovery after a stroke, particularly in terms of joint pain, passive joint motion, and motor function. The FMA has an established reliability of 0.95 (**Richard, 2008)**. The FMA is a numerical scoring system that evaluates four facets of physical performance: motor performance, sensation, passive joint motion, and joint pain. The motor performance scores range from 0 to 66, with scores ≥36 indicating normal motor function, and ≤ 32 indicating severe motor function. Scores for sensation, vary from 0 to 24, where a score ≥ 10 indicates normal sensation and a score of ≤ 3 indicates severe sensory impairment. For passive joint motion, the scores vary from 0 to 24, where, a score ≥19 indicates normal movement and a score ≤12 indicates no movement. Finally, for joint pain, a score ranges from 0 to 24, where zero indicates the absence of pain and a score ≥16 indicates severe pain.

Method:

Validity and reliability of the tools:

- Tool I was developed by the researchers. The Arabic version of tool II was utilized in this study to eliminate elderly with moderate to severe cognitive impairment. The English versions of tools III and IV were used. The content validity of tools III and IV was verified by a panel of seven (7) experts in gerontological nursing, neurology, and physical rehabilitation, and the appropriate alterations were made as a result. Furthermore, for the study purposes, the internal consistency of tools III and IV was examined by the researchers to determine their reliability ($r_=$ 0.88 and 0.90 respectively).

Administrative and ethical considerations:

- A letter issued by the dean of Mansoura University's faculty of nursing was used to secure the directors of the study setting's official consent to conduct the study. The letter explained the study's purpose and procedures and was supported by a copy of the data collection form. The existing study was accepted by the Ethical Committee of Mansoura University's Faculty of Nursing in Egypt; Approval Number (0369) and Decision Date: 28/12/2022.
- The Helsinki Declaration (DoH-Oct2008) was followed in all aspects of the study's research ethics. Some Egyptian elderly and/or their families would rather express oral consent to participate in the current study than sign a form. So, after presenting all study participants and their relatives with an appropriate understanding of the study's purpose and procedures informed written and/or oral consent was obtained. The researchers battled to safeguard the privacy and anonymity of the study participants, as well as the confidentiality of their acquired data. The researchers notified the study participants that they could refuse or withdraw from the study at any time for any reason and that the study maneuvers would not cause actual or prospective harm.

Pilot study:

A pilot study was done on four patients, representing roughly 10% of the projected sample size, to test the clarity of the data collecting form and the feasibility of the research process. The tools were finalized following the improvements that had to be made in light of the pilot study's findings. The patients who shared in the pilot study were excluded from the study sample.

Fieldwork:

Assessment phase:

- The researchers attended the study setting six days per week from 9 a.m. to 2 p.m. for consecutive ten working days to recruit the study participants (Three to four elders were selected each day). Where, all participants who met the inclusion criteria were examined individually by the researchers in a quiet corner of the study setting to assess their sociodemographic and clinical data, cognitive functions, degree of spasticity, and sensory-motor recovery after a stroke using tools I, II, III, and IV respectively.
- Completing the study tools took 45-50 minutes for cooperative elders to establish the pre-test baseline data. Using permuted block randomization, the patients were assigned randomly to the intervention group (Mirror therapy, $n_=$20) or the comparison group (Sham therapy, $n_=$20). Sham therapy; is a phony treatment that imitates mirror therapy by utilizing the non-reflective side of the mirror.
- The researchers and the study participants discuss the appropriate schedule for future home visits to start the mirror or the sham therapy sessions. This schedule is usually on the opposite three days of the participants' routine schedule of physiotherapy at the Rheumatology and Rehabilitation Unit (Conventional therapy).

Planning phase:

Based on a review of the literature, the researchers prepared the scenario of sessions and designed the mirror and the sham box **(Lee et al, 2020 & Jaafar et al, 2021)**. Both boxes are triangular (30×30 inch), and there is enough room between their surfaces for the elder's affected hand to fit inside. It is constructed of light woody material. The mirror box had only one reflective side, while in the sham box, all its sides were non-reflective.

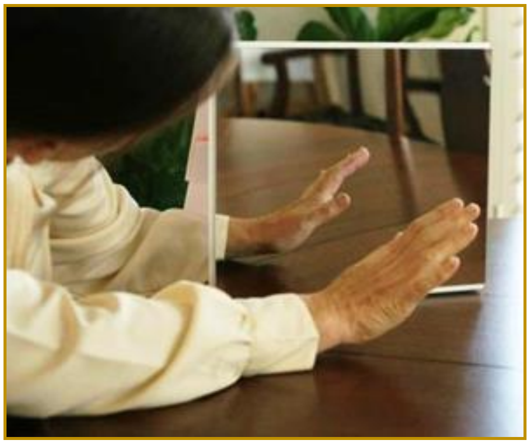

Figure (1): The mirror box
(**https://www.transitionsphysiotherapyperth.com.au/what-is-mirror-box-therapy/**)

Implementation phase:

- The mirror therapy sessions were implemented for the intervention group and the sham therapy for the comparison group individually for all participants at their homes through eighteen sessions where six to seven patients were visited per day for three sessions per week for six consecutive weeks. The duration of each session was 45 min.
- In the 1st session for both groups, after introducing themselves and welcoming the elderly and their family members, the researchers presented the sessions' goals, timetable, required equipment, and procedures to be followed during the upcoming sessions.
- The 2nd session for both groups was devoted to discussing the various stroke-related problems and therapy approaches for elderly patients.
- For the intervention group, the third session covered the idea and fundamentals of mirror therapy as well as its function in improving the elderly person's independence after a stroke. For the comparison group, this session covered the value, variety, and principles of upper-limb exercises for stroke elderly patients.
- During sessions four through eighteen, the researchers led the participants through practical exercises. The participant was seated at a table with a suitable chair positioning. At the participant's midline, the researchers placed either a mirror or sham box vertically on the table. The participant was instructed to place both hands on the table. For the participant in the intervention group, the affected hand was placed behind the reflective side of the mirror box, while the unaffected hand was placed in front of it. For participants in the comparison group, the affected hand was placed in the space between the two non-reflective sides of the sham box, while the unaffected hand was placed in front of it.
- The researchers demonstrated for both groups each exercise, such as; fanning out the hand, finger, and thumb abduction, making a fist and release, wrist flexion, extension, abduction, and adduction. As well as, finger flexion, and extension, lateral prehension, pad-to-pad, pad-to-side, pad-to-pad grip, grasping objects (card, pencil, small ball, key, disposable cup, and tweezers), single finger movement, thumb opposition, and the participant redemonstrated the same exercises using their unaffected hand and try to move the affected hand as much as possible to mimic the movements of the unaffected hand.
- While performing exercises the participant in the intervention group was instructed not to look at the affected hand and instead to focus on the reflection of the unaffected hand in the mirror. Participants who wore glasses were reminded to keep them on throughout the sessions

Evaluation phase:

To test the study hypotheses, the sensory-motor functions were assessed for participants in both groups at three points using the Fugl- Meyer Assessment tool (Tool IV): during the recruitment phase (pre-test), at the end of the 12th session (post-test I), and again at the end of the 18th session (post-test II). The data-gathering procedure started from the beginning of January 2023 through the end of June 2023.

Statistical Analysis

Using a Personal Computer (PC), the data gathered from the study sample was revised, coded, and input. The Statistical Package for Social Sciences (SPSS) version 22 was used for computerized data entry and statistical analysis. Descriptive statistics were used to present the data in the form of frequencies, percentages, and Mean ± SD. A correlation coefficient “Pearson correlation” is a numerical measure of some type of correlation, meaning a statistical relationship between two variables. A t-test is a statistical test that is used to compare the means of two groups. The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of the two groups. Chi-square is a statistical test that examines the differences between categorical variables from a random sample to determine whether the expected and observed results are well-fitting. Monte Carlo exact test and Fisher exact test (FET) are alternatives for the Chi-square test if there were many small expected values.

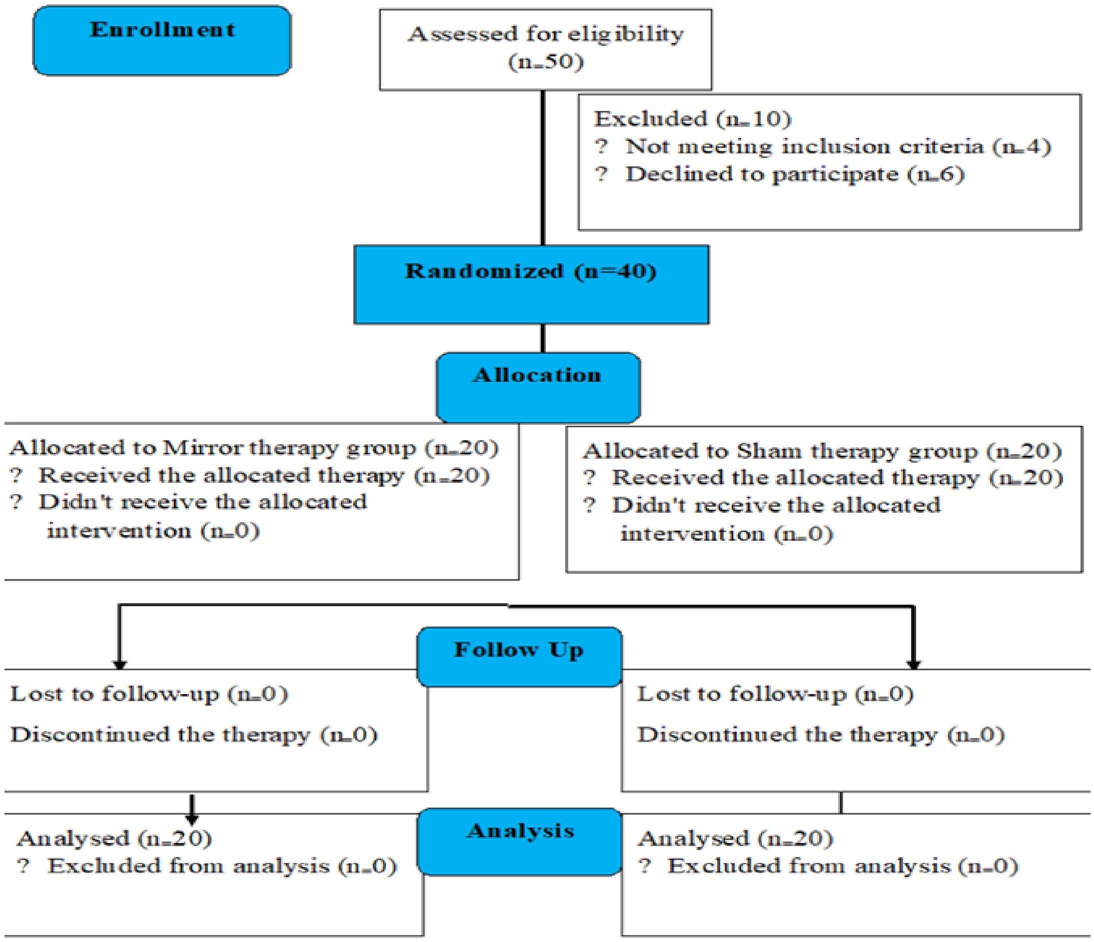

Figure (2): ***The flowchart of the study***

Results

Table (1): Distribution of studied elderly patients in the intervention and comparison group according to their socio-demographic characteristics (n=40)

Characteristics	Intervention group (N=20)		Comparison group (N=20)		Test (P value)
	n	%	n	%	
Age:					
60 - <65	11	55	12	60	X^2=1.890 (>0.05)
65 - <70	5	25	5	25	
70 - 75	4	20	3	15	
Mean± SD	65.70±6.11		65.35±7.34		
Gender:					
Male	13	65	12	60	X^2=2.001 (>0.05)
Female	7	35	8	40	
Education level:					
Illiterate	3	15	4	20	MC=1.776 (>0.05)
Read and write	4	20	4	20	
Primary	2	10	3	15	
Preparatory	5	25	5	25	
Secondary	4	20	3	15	
Bachelor	2	10	1	5	

Not significant at p>0.05

Table (2): Distribution of studied elderly patients in the intervention and comparison group according to their stroke-related clinical characteristics (n=40)

Characteristics	Intervention group (N=20)		Comparison group (N=20)		Test (P value)
	N	%	n	%	
Duration of affection					
One month - < 4 months	16	80	17	85	FE=0.677 (>0.05)
4 Months - < 8 months	3	15	3	15	
8 Months - 12 months	1	5	0	0	
Mean± SD	1.25± 0.550		1.15±0.366		
Affected side:					
Right	11	55	10	50	X^2=1.003 (>0.05)
Left	9	45	10	50	
Dominant side:					
Right	18	90	19	95	FE=1.056 (>0.05)
Left	2	10	1	5	
Associated chronic illness:					
None	4	20	3	15	MC=2.065 (>0.05)
HTN	7	35	6	30	
DM	5	25	7	35	
Others (such as renal and liver diseases)	4	20	4	20	

Not significant at p>0.05

Table (3): Analysis of FMA score means within each of the intervention and comparison groups on their pre-test, post-test I, and Post-test II (n=40)

Parameters of the sensory-motor recovery	Pre-Test Mean ±SD	Post Test I Mean ±SD	Post Test II Mean ±SD	Anova (P value)
Intervention group				
Motor Performance	16.24±4.24	25.02±5.11	51.32±4.89	13.567 (<0.001) **
Sensation	4.78±1.41	7.64±1.96	10.38±0.76	12.071 (<0.001) **
Passive Joint Motion	10.33±2.58	14.70±3.07	19.25± 2.60	10.556 (<0.001) **
Joint Pain	17.08±3.5	13.51±2.87	4.01±1.02	9.865 (<0.001) **
Comparison group				
Motor Performance	17.01±3.66	16.99±4.18	17.80±2.90	2.087 (>0.05)
Sensation	5.01±1.11	5.40±1.12	6.00±2.03	1.998 (>0.05)
Passive Joint Motion	10.87±2.47	11.29±3.56	11.58±2.77	2.004 (>0.05)
Joint Pain	17.93±3.56	16.53±2.79	16.22±1.89	1.643 (>0.05)

***Highly significant at p ‹0.01.* *Not significant at p>0.0*

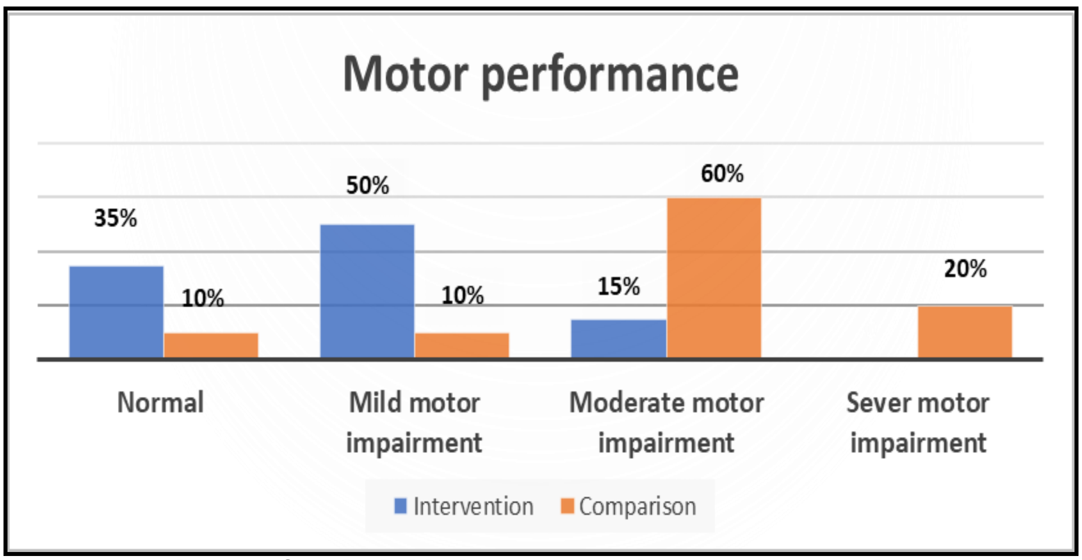

Figure (3): Distribution of studied elderly patients in the intervention and comparison group according to their motor performance at the post-test II (n=40)

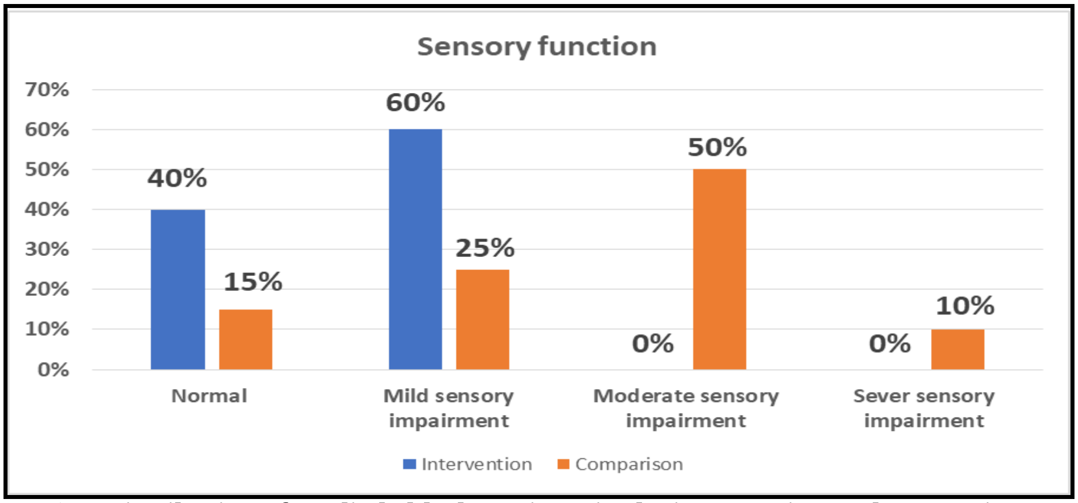

Figure (4): Distribution of studied elderly patients in the intervention and comparison group according to their sensory function at the post-test II (n=40)

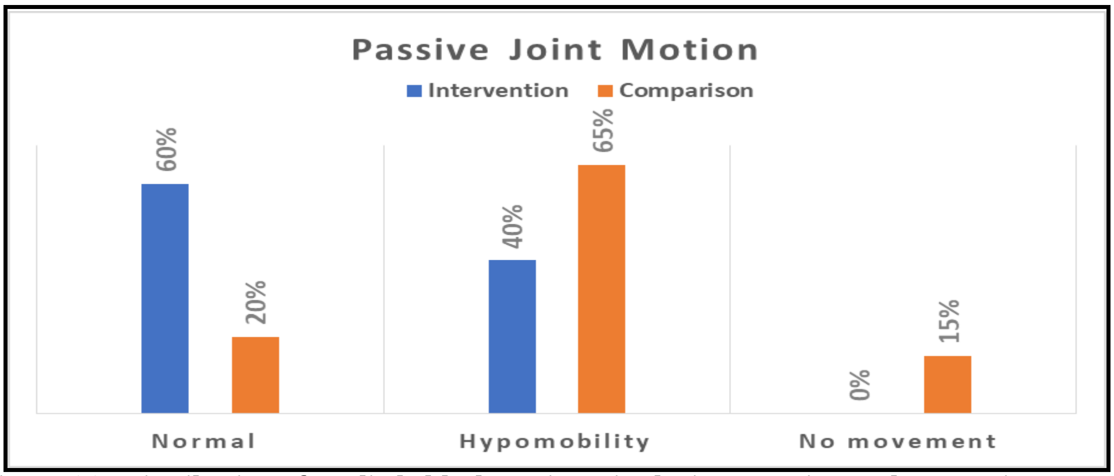

Figure (5): Distribution of studied elderly patients in the intervention and comparison group according to their passive joint motion at the post-test II (n=40)

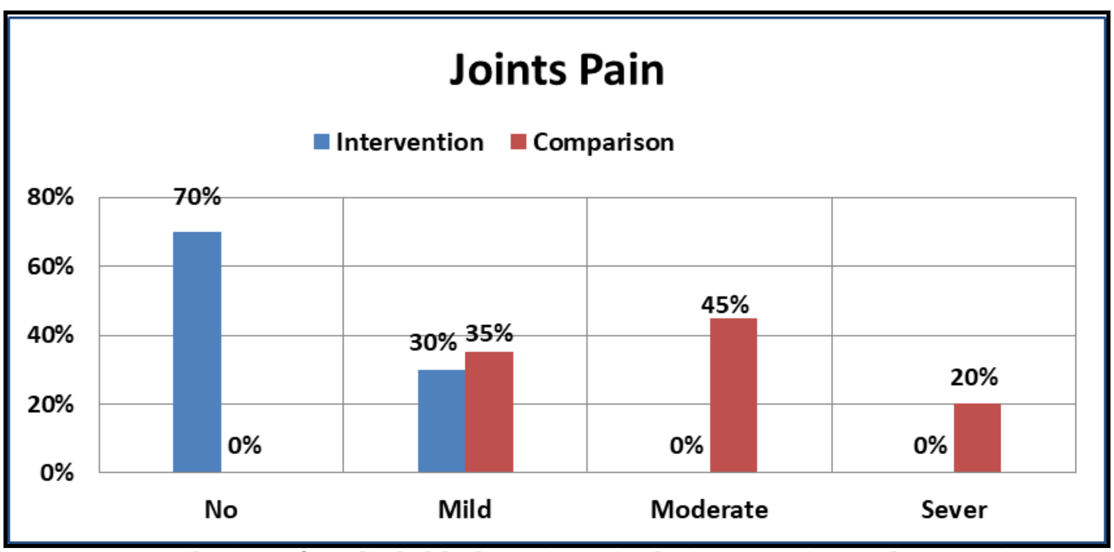

Figure (6): Distribution of studied elderly patients in the intervention and comparison group according to their joint pain at the post-test II (n=40)

Table (4): Comparison of means of FMA score between the intervention and comparison group on their pre-test, post-test I, and Post-test II (n=40)

Parameters of sensory-motor recovery	Intervention group (N=20)	Comparison group (N=20)	t-test	P value
	Mean ±SD	Mean ±SD		
Pre-Test				
Motor Performance	16.24±4.24	17.01±3.66	2.075	>0.05
Sensory Function	4.78±1.41	5.01±1.11	1,657	>0.05
Passive Joint Motion	10.33±2.58	10.87±2.47	2.111	>0.05
Joint Pain	17.08±3.5	17.93±3.56	1.730	>0.05
Post-Test I				
Motor Performance	25.02±5.11	16.99±4.18	8.033	<0.001**
Sensory Function	7.64±1.96	5.40±1.12	9.672	<0.001**
Passive Joint Motion	14.70±3.07	11.29±3.56	8.672	<0.001**
Joint Pain	13.51±2.87	16.53±2.79	10.999	<0.001**
Post-Test II				
Motor Performance	51.32±4.89	7.80±2.90	11.231	<0.001**
Sensory Function	10.38±0.76	6.00±2.03	10.762	<0.001**
Passive Joint Motion	19.25±2.60	11.58±2.77	12.090	<0.001**
Joint Pain	4.01±1.02	16.22±1.89	9.771	<0.001**

***Highly significant at p ‹0.001.* *Not significant at p>0.05*

Table (5): Correlations between variables of FMA among the studied older adults in the intervention group (Mirror therapy)

Studied variables		Motor function	Sensory function	Passive joint motion	Joint pain
Motor function	r. p		0.499 <0.001**	0.501 <0.001**	-0.399 <0.001**
Sensory function	r. p			0.487 <0.001**	-0.564 <0.001**
Passive joint motion	r. p				-0.571 <0.001**
Joint pain	r. p				

***Highly significant at p ‹0.001.*

Table (6): Correlations between variables of FMA among the studied older adults in the comparison group (Sham therapy)

Studied variables		Motor function	Sensory function	Passive joint motion	Joint pain
Motor function	r. p		0.500 <0.001**	0.471 <0.001**	-0.452 <0.001**
Sensory function	r. p			0.601 <0.001**	-0.549 <0.001**
Passive joint motion	r. p				-0.480 <0.001**
Joint pain	r. p				

***Highly significant at p ‹0.001.*

As shown in **Table (1)**: This intervention is conducted on 40 elderly patients. They were divided into an intervention group (n=20) and a comparison group (n=20). Both groups are parallel in all characteristics. Regarding their age, the mean age ±SD of the intervention and the comparison group is 65.70±6.11 and 65.35±7.34 years, respectively. There is no statistically significant difference (p>0.05) between both groups as regards their age, gender, and educational level.

Table (2): Shows that the mean duration of stroke in the intervention and the comparison group is 22.50±9.31 and 19.51±7.83 respectively. There is no statistically significant difference (p>0.05) between the two groups regarding the duration of the stroke, affected side, dominant side, and associated chronic illness.

Table (3): Reveals that there is a highly statistically significant difference in the mean scores of all parameters of the sensory-motor recovery of the intervention group (p<0.001) at the pre-test, post-test I, and post-test II. However, there is no statistically significant difference in the mean scores of all of these parameters in the comparison group (p>0.05) at the pre-test, post-test I, and post-test II.

Figure (3): Clarifies that at post-test II, nearly two-thirds of the comparison group (60%) had moderate motor impairment, but half of the intervention group (50%) had mild motor impairment.

Figure (4): Indicates that at post-test II, half of the comparison group (50%) had moderate sensory impairment, while nearly two-thirds of the intervention group (60%) had mild sensory impairment.

Figure (5): Portrays that at post-test II, almost two-thirds of the comparison group (65%) had hypo-mobility of passive joint motion, while nearly two-thirds of the intervention group (60%) had normal passive joint motion.

Figure (6): Displays that post-test II, nearly half of the comparison group (45%) had moderate joint pain whereas; nearly three-quarters of the intervention group (70%) had no joint pain.

Table (4): Reflects that there is no statistically significant difference between the intervention and comparison group as regards mean scores of all parameters of the sensory-motor recovery (p> 0.05) at the pre-intervention phase, while there is a highly statistically significant difference between the intervention and comparison group as regards mean scores of all parameters of the sensory-motor recovery (p< 0.001) at the post-test I and the post-test II.

Table (5): Illustrates that there are highly statistically significant positive correlations (p<0.001) between FMA variables among the studied older adults in the intervention group namely: motor function, sensory function, and passive joint motion. While, highly statistically significant negative correlations (p< 0.001) were found between FMA variables: joint pain, motor function, sensory function, and passive joint motion among the intervention group.

Table (6): Shows that there are highly statistically significant positive correlations (p< 0.001) between FMA variables among the studied older adults in the comparison group namely: motor function, sensory function, and passive joint motion. Besides, highly statistically significant negative correlations (p<0.001) existed between FMA variables: joint pain, motor function, sensory function, and passive joint motion among the comparison group.

Discussion

Stroke is the primary contributor to severe permanent disabilities among elderly patients. More than 60% of stroke survivors suffer from constant neurologic deficits that disrupt daily living activities. After a stroke, the motor function of the extremities is commonly compromised, resulting in functional mobility limits, causing limitations in functional mobility. It has been revealed that the motor system's functional association, including the primary motor cortex, can be modulated by both passive inspections of movement of the contralateral limb and ipsilateral limb movement. Moving the unimpaired limb is the main focus of mirror therapy, a relatively new therapeutic method. In stroke patients, mirror therapy creates a visual illusion of the impaired limb's better movement ability, which entails performing movements of the unaffected limb while examining its mirror reflection superimposed over the (unseen) affected limb **(Chinnavan et al., 2020).** The current study demonstrated that mirror therapy is beneficial in enhancing elderly stroke patients' upper limb sensory-motor recovery.

As regards the effect of the home-based mirror therapy on the sensory-motor recovery of the upper limb of the studied older adults, the current result revealed that there was a highly statistically significant difference in the mean scores of all parameters of the FMA scale in the intervention group at pre-test, post-test I, and II. However, there was no statistically significant difference in the mean scores of all of these parameters in the comparison group. Also, when comparing the means score of the FMA scale between both groups on their post-test I, and II, a highly statistically significant difference was reported.

This outcome may be related to the use of mirror therapy, which is a straightforward and affordable intervention that the elderly can quickly understand, especially since the majority of the studied elders can be categorized as young old with adequate educational levels. In addition, these findings might be due to the researchers' close observation and their support for the studied elderly during the mirror therapy sessions.

This is consistent with research conducted in Iran by **Ashrafi et al., (2022)** who reported that there was a statistically significant difference in the sensory-motor recovery between the group using the mirror therapy and the group using the non-reflective surface. Also, the results of the current research were compatible with the findings of other studies conducted by **Gokila, (2016)**, **Choi et al., (2019)**, and **Putri et al., (2020)**, who stated that using mirror therapy after stroke is a potential technique to enhance sensory-motor recovery of the upper extremity. In addition, other studies conducted in India by **Yumnam et al., (2019)** and in Bangladesh by **Chinnavan et al., (2020)** reported that there was a significant improvement in the sensory-motor recovery of the upper limb and self-care daily activities of studied participants after using the mirror therapy when it was administered in conjunction with a conventional stroke rehabilitation program. Also, a study done in India by **Baby et al., (2014)** stated that the group receiving home-based mirror therapy together with conventional therapy showed statistically and clinically significant improvement in hand functions compared to the group receiving sham mirror therapy along with conventional therapy.

Regarding the comprehensive review of the improvements produced by MT therapy on the first and second parameters of the sensory-motor recovery (**the motor performance and sensory function**) of the upper limb; the findings of the current study displayed that the intervention group was improved when compared to the other group as; half of the intervention group had mild motor and sensory impairment at the post-test I, and II compared with two-thirds of the comparison group who had moderate motor and sensory impairments. These results were corroborated by research that claimed using mirror therapy produces a reflection of a person's unaffected limb in place of the affected limb when performing exercises. These optical illusions allow the brain to believe as if the two extremities are moving symmetrically **(Chinnavan et al., 2020)**.

These findings were confirmed by **Gokila, (2016)**, **Radajewska et al., (2017**), **Chinnavan et al., (2020**), and **Devi et al. (2022),** who displayed that there is a reported improvement in upper-limb motor performance in the experimental group after mirror therapy compared with the control group. Moreover, another study by **Colomeret al., (2016)** found that mirror therapy, even at chronic stages of stroke, can improve patients' motor performance of the upper limb. Contrary to the current study findings, a study performed in Turkey by **Yeldan et al., (2015)** showed that there is no improvement in their upper extremity's motor function as a result of using the MT. This discrepancy in the results may be due to the differences in the type of movements performed in the MT session, the length of the intervention, the diversity of tools used, and the selection criteria for the study's participants. In this line, studies conducted by **Gokila, (2016), Lee et al., (2019), & Chinnavan et al., (2020)**, suggested that MT showed significant effects on sensory function among stroke patients. These results were also supported by a study done by **Arya et al., (2018)** which stated that there was a significant increase (P <.004) up to 30% in the positive touch-response for the hand quadrants among the experimental group using the MT in comparison to only 13.5% among the control group.

Regarding the third and fourth parameters of sensory-motor recovery **(passive joint motion, and joint pain)**, the results of the present study showed that at the post-test I, and II, nearly two-thirds and less than three-quarters of the intervention group had normal passive joint motion, and no joint pain respectively. On the other hand, nearly two-thirds and less than half of the comparison group reported hypo-mobility on the passive joint motion and moderate joint pain. These findings may be explained in the light of the reported enhancement of the studied older adults' motor and sensory function. Furthermore, this outcome may be due to the long duration of the implemented therapy and the compliance of the studied elderly patients to the researchers' instructions. In this line, studies conducted by **Gokila, (2016) & (Thieme, et al 2018)** reported improvement in passive joint motion and reduction in pain sensation among the studied participants post-stroke after using mirror therapy.

Conclusion:

Home-based mirror therapy is an efficient, simple, and affordable nursing intervention that can be used as an adjunct therapy with conventional therapy to enhance the sensory-motor recovery of the upper limb in elderly patients' post-stroke. This is based on the clear and noticeable improvements in the elderly patients' sensory-motor functions in the intervention group compared to the comparison group.

Recommendations:

- An in-service education program should be designed for the Gerontological nurses to enrich their knowledge related to mirror therapy as a rehabilitative intervention to enhance the upper extremity sensory motor function for elderly patients' post-stroke.
- Mirror therapy can be practiced in either clinical or community settings to enhance the upper extremity sensory motor function of stroke elderly patients.
- Continuous support and motivation are needed for stroke elderly patients to guarantee their permanent incorporation of mirror therapy regimens into a daily routine.
- Other studies should be conducted to investigate the effect of home-based mirror therapy on the quality of life of elderly patients' post-stroke.

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