The Effectiveness of Exercises Based Mirror Therapy on Functional Activity of the Limbs among Stroke Patients

Safaa Mohamed Hamed[1], Ebtsam Saad Soliman[2] and Doaa Mohamed Mahmoud[3]

(1) Assistant professor of Medical Surgical Nursing, Faculty of Nursing, Benha University, Benha, Egypt and (2,3) Lecturer of Medical Surgical Nursing, Faculty of Nursing, Benha University, Benha, Egypt.

Abstract:

Context: Cerebrovascular stroke is a perilous health concern that results in motor and functional impairments necessitating continuous care. It is the primary cause of disability and the second leading cause of mortality worldwide. Mirror therapy is an emerging alternative treatment that is simple, cost-effective and patient-centered. **Aim:** The study aimed to evaluate the effectiveness of exercises-based mirror therapy on functional activity of the limbs among stroke patients. **Methods**: A quasi-experimental research design (pre/post-test) was employed on a purposive sample of 63 patients diagnosed with stroke admitted to department of Psychiatry and Neurology and outpatient clinics at Benha University Hospital, Qualubyia governorate, Egypt. The study utilized the following tools, I: Patients' Structured Interview Questionnaire, II: Fugl-Meyer Assessment for upper extremity (FMAUE), III: Brunnstrom Stages Assessment, IV: Modified Ashworth Scale (MAS) and V: Barthel activity daily living (ADL) Index Scale. **Results** show a statistically significant enhancement in the overall patients' knowledge mean score after implementing the exercises-based mirror therapy with P<0.001. Also, a statistically significant improvement in the overall functional ability of upper limbs (FMAUE), as the total mean score was 54.022±8.363 which increased to74.302±10.986 post implementation of exercises-based mirror therapy. Total mean score of Barthel ADL Index Scale was 20.52 ± 3.58 pre implementation which indicating poor ADL, but improved significantly to 28.80±6.72 post implementation, which indicating better ADL with p<0.001. **Conclusion:** The exercises-based mirror therapy is efficient in improving the stroke patients' upper limb functional activity. **Recommendations:** Stroke patients should consider exercises-based mirror therapy as an accessible and practical approach for enhancing upper limb functionality.

Keywords: Exercises Based Mirror Therapy, Functional Activity, Stroke patients

Introduction

One of the prevailing neurological disorders is stroke that results in death, illness and disability among adults. **(Kwakkel et al., 2023).** According to the WHO, stroke is characterized by emerging clinical symptoms of localized or widespread disruptions in brain function, persisting for over twenty four hours or resultant in death, with no obvious cause other than a vascular incident **(Mallikarjuna & Salikar, 2023).**

Stroke episodes may occur in two ways ischemic as a result of vessel (arterial or venous) occlusion and hemorrhagic (intraparenchimal or subarachnoid) as a result of distruption of vascular integrity. Ischemic strokes account for 62.4% of all global stroke incidents **(Koçkar & Koyuncuoğlu, 2024).**

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Motor paralysis following a stroke typically affects the distal upper limbs more severely than the lower limbs, with finger extension being one of the slowest functions to recover **(Lamont et al., 2021)**. 80% of stroke patients survive at the critical stage. However, 30%-66% percent of these survivors become incapable to use their affected arm, despite regaining the ability to walk **(Sekome, 2023).** Upper extremities often recover more slowly than lower extremities. The "learned nonuse" hypothesis suggests that negative reinforcement may result from persistent failure to utilize the affected arm during the acute and subacute periods. Although spontaneous recovery and rehabilitation can gradually restore motor function, this process is hindered by early setbacks **(Tesio et al., 2023).**

One of the emerging therapeutic interventions for patient with stroke is exercise-based mirror therapy. It is cost-effective, straightforward and primarily patient-directed, aimed at enhancing upper limb function. This technique involves the patient performing movements with the unaffected limb while a mirror placed in the mid-sagittal plane creates a visual illusion that the affected limb is moving, aiding in motor recovery **(Sampath et al., 2021).** One unique form of rehabilitation that can increase mobility is mirror therapy. It can enhance mobility in the hands, arms and sometimes even the legs after a stroke. The most appealing feature is its accessibility for patients with very limited mobility **(Pamidimarri et al., 2024).**

Nursing entails more than merely giving treatments and distributing drugs. Teaching patients about managing and preventing medical disorders is an obligation of nurses. Physical therapists and nurses frequently employ integrative therapy, such mirror therapy, more and more. Results reveal that, regardless of the paucity of research, there is a need for education regarding the application of exercises based mirror therapy for the management of affected limbs. The span of treatment, safety precautions with mirror therapy, and range-of-motion exercises tailored to the patient's capability should all be imparted to nurses and other healthcare professionals. In order to help patients and their families better manage the damaged limb, nurses should inform them about mirror treatment effectively. **(Roustaee et al., 2023).** Exercises-based mirror therapy has demonstrated effectiveness in boosting motor function in the upper limb among stroke survivors **(Muñoz et al., 2023).**

Significance of the study

Stroke is a significant worldwide health issue that incurs high costs for both acute and chronic care, contributing substantially to the overall disease burden. Upper-limb impairment is a frequent complication, with up to sixty percentages of survivors need rehabilitation for a long-term **(Eliana et al., 2023).** One of common and problematic effect of stroke is the paretic upper limb, which increases activity limitations. Reports indicate that 55%-75% of stroke survivors experienced upper-extremity impairments and up to 85% develop hemiparesis **(Anam et al., 2023)**. Around sixty six percent of patients experience deficits in bodily functions, while approximately three fourths encounter limitations in daily living activities **(Sturm et al., 2020).**

Stroke is the most prevalent acquired neurological condition among adults worldwide. In Egypt, the stroke incidence is

240 per 100,000 people (250,000 new cases annually), with 10% dying within the first month post-stroke and the rest suffering varying degrees of disability (**El hassanien et al., 2023).**

As well as, from the clinical experience, observation of actual situations and according to increased number of strokes patients, the researchers noticed that there is an increase of stroke complications among these patients at Benha university hospital. A retrospective analysis of statistical records indicated that the number of admitted patients to the Psychiatry and Neurology department and outpatient clinic at Benha University Hospital over the past three years (2021, 2022, 2023) was approximately 1446, 2981 and 3202 patients, respectively (**Statistical Office, Benha University Hospital, 2023).**

Aim of research

The aim of this study was to evaluate the effectiveness of exercises-based mirror therapy on functional activity of the limbs among stroke patients.

Research hypotheses

H1: Stroke patients' knowledge score could be significantly higher after exercises-based mirror therapy implementation compared to pre implementation level.

H2: The mean score of extremity motor function among stroke patients could be significantly improved after exercises-based mirror therapy implementation compared to pre implementation level.

H3: Mean score of limb muscle strength among stroke patients could be significantly increased post exercises-based mirror therapy implementation compared to pre implementation level.

H4: Activity daily living score among stroke patients could be significantly improved post

exercises based mirror therapy implementation compared to pre implementation level.

Operational definitions:

Functional activity: Functional state determined for stroke patient's through assessment of upper extremity to gauge the extent of motor function impairment and recovery, assessment of improvement in muscle strength, measure the ability to perform activities of daily living.

Subjects & Method

Research Design

This study utilized the quasi-experimental research design employing a pre/post approach. The aim of a quasi-experimental design is to establish a cause-and-effect relation between the independent and dependent variable. But unlike an actual experiment, a quasi-experiment does not depend on random assignment (**Reichardt, 2019).** The quasi-experimental design includes a wide range of nonrandomized or partially randomized pre-post intervention studies (**Handley et al., 2018).** Exercise based mirror therapy is the study's independent variable and functional activity of the limbs among stroke patients is the dependent variable.

Setting:

Department of Psychiatry and Neurology and Outpatient clinics affiliated to Benha University Hospital, Qualubyia Governorate, Egypt served as the study's setting. The Psychiatry and Neurology department located in the six floor of medical building contains two patients' rooms (one for females and one for males). Each room including 6 beds.

Subjects:

Purposive sample of stroke male and female patients between 20-60 years of age with hemiparesis after stroke which affected

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upper limb function. The sample size for the study was determined based on the patient flow rate admitted to the previously mentioned settings from the previous year, as indicated in the census report.

Size: Using the Epi info (7) statistical tool, the sample size was calculated at a 95% confidence level and an acceptable margin of error of 5% based on the admissions data from the Department of Psychiatry and Neurology and outpatient clinic from Benha University Hospital Census (2023). The total sample size was 63 patients.

Exclusion criteria

-Patients exhibiting hemineglect
- Patients with Wernicke's or mixed aphasia
-Patients had visual impairment such as homonymous hemianopsia

Tools of data collection

The study utilized the following tools to collect pertinent data:

Tool 1: Patients' Structured Interview Questionnaire

After studying pertinent and recent literatures, the researchers constructed this Arabic-language questionnaire based on **Klinkwan et al. (2021); Caterina et al. (2022); Johnson & Rochelle (2023) and Miller (2022)**. It involved three main parts as follow:

Part 1: Patients' personal data including age, patients' gender, their marital status, residence, educational level, occupation and living status.

Part 2: Patients' medical data including onset of the disease, type of lesion, affected side and number of stroke episodes.

Part 3: Patients' knowledge assessment: It aimed to assess patients' knowledge regarding stroke and exercises based mirror therapy, it contained two sections:

Section 1: Patients' knowledge about stroke, it consisted of ten MCQs including definition of stroke, types, causes and possible risk factors, clinical manifestations, investigations, goal of treatment and medications.

Section 2: Patients' knowledge about exercises based mirror therapy; it consisted of seven multiple choice questions about definition, purpose, steps and techniques.

Scoring system:

Patient' knowledge was scored as every question had a score range from 0 to 1. The right response received a score of 1, whereas a wrong response received a score of zero. The total score of all questions ranged from 0-17 , converted into percent and classified as satisfactory knowledge level if score ≥75% and unsatisfactory knowledge level if score <75%.

Tool II: **The Fugl-Meyer Assessment for upper extremity (FMAUE)**: It was utilized to gauge the extent of motor function impairment of the upper limbs, allowing for the highest score of 66 points. It was designed by **Fugl-Meyer et al., 1975**. The motor function assessed comprised 33 distinct movements categorized under four groups: hand/finger, wrist, shoulder/elbow/forearm and coordination.

The scoring system involves the evaluation of 33 movements. Tasks are evaluated against a three-point Likert scale: zero indicates inability, one indicates partial ability and two indicates near-normal ability.

Tool III: Brunnstrom Stages Assessment:

Assessment of motor recovery in the upper extremity was conducted using Brunnstrom's stages, a method adopted from the work of **Gurbuz et al., 2016.** This evaluation divides the recovery process into six grades: Grade1 characterized by the absence of spontaneous movement, with no

motion in either the upper or lower extremities; Grade 2 involved responses in the joints, with some movement and minimal spontaneous actions; Grade 3demonstrated random movements, with ability to grasp objects but not to extend full; Grade 4 indicated separation of movements, including the pinching ability and performing minor extensions; Grade 5 showed muscle tone gradual return with delicate movements, along with the dependent and simultaneous finger extension and Grade 6 approached normal motor function, but with suboptimal speed and accuracy.

Tool IV: Modified Ashworth Scale (MAS):-

The Modified Ashworth Scale originally adopted from the work of **Arya and Pandian in 2013**. This scale involved applying resistance to the muscles of the upper extremity. When testing a muscle primarily responsible for flexing the joint, the stroke patient is positioned supine, with the joint moved from maximum flexion to maximum extension within one second (counting "one thousand one"). Conversely, when evaluating a muscle primarily responsible for extending the joint, the joint is placed in maximum extension and then moved to maximum flexion within the same time frame.

Scoring system: Scoring followed these criteria: When there was no significant improvement in muscle strength, a score of 0 was given. A score of one denoted a slightly stronger muscle, as demonstrated by movements such as holding and releasing or feeling very little resistance at the ends of the range of motion when flexion or extension is performed. A score of 1+ indicated negligible resistance through less than half of the range of motion, followed by a minor rise in muscle tone indicated by snapping sensations. A score of two indicated a considerable improvement in muscle strength over most of the range of motion, even though the affected part(s)

moved easily. A score of three denoted a significant rise in muscular tone that made passive movement challenging. Additionally, a score of 4 denotes rigidity in the affected extremity (ies), either during flexion or extension.

Tool V: Barthel ADL Index Scale

The Barthel index (BI) is a scale that allows measuring the ability to perform a selection of activities of daily living and conducted both before and after the intervention, BI was adopted from **Mahoney and Barthel (1965).**vIt has been widely used to evaluate behavior across ten variables related to daily living activities of patients with stroke, including bladder and bowel control, feeding, toilet use, bathing, grooming, dressing, transfers (from bed to chair and back), mobility on surface level and stair climbing.

Scoring system:

Total scores of BI ranging from 0 (worst mobility in activities of daily living) to 100 (full mobility in activities of daily living) **Musa & Keegan, (2018).** Like other ADL instruments, the BI items possess a hierarchy of difficulty and yield ordinal intervals between adjacent scores. Therefore, as **Yi et al. (2020)** indicated, practitioners and researchers may have difficulty interpreting the clinical meaning of BI summary scores or changes in scores

A total score of 100 indicates that the patient is entirely independent, requiring no assistance or supervision. Scores between 91 and 99 signify minimal dependency. A score range of 75 to 90 denotes mild disability. Moderate disability is indicated by scores from 50 to 74, while severe disability is represented by scores between 25 and 49. Scores from 0 to 24 reflect very severe disability, indicating that the patient cannot perform daily living activities independently. **Adamson (2019) and Ohura (2017).**

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Contents validity:

They were assessed by a panel of five professionals from the Medical and Nursing fields. Three professors of Medical-Surgical Nursing from Benha University's Faculty of Nursing, one professor of neurology and one professor of physiotherapy from Benha University's Faculty of Medicine. They evaluated the instruments' applicability, comprehensiveness and clarity.

Tools reliability:

The instruments' reliability were tested by the Cronbach alpha test, yielding values of 0.925 for the knowledge questionnaire, 0.917 for the FMAUE Scale, 0.97 for the Brunnstrom stages, 0.93 for the MAS, and 0.887 for the Barthel ADL Index Scale.

Pilot study:

Ten percent of the sample (6 patients) participated in a pilot study to evaluate the tools' suitability, comprehensibility and completion time. Upon reviewing the pilot data, it was decided that no changes were required. The primary sample comprised these patients.

Ethical considerations: The study first received approval from the Scientific Research and Ethics Committee of the Faculty of Nursing at Benha University. Subsequently, official endorsements were secured from the dean of the nursing faculty and the director of the psychiatry and neurology department at Benha University Hospital. Throughout the research process, all ethical guidelines were strictly adhered to.

The study's aim and objectives were communicated to each patient, along with their freedom to discontinue participation at any moment. Patients who took part in the research gave verbal and written consent. Researchers ensured the privacy and anonymity of their participants.

Fieldwork: The process of data collection spanned six months, from the beginning of January 2024 to the end of June 2024. During this period, researchers visited the designated study settings twice a week (from 9:00 am to 12:00 pm), using the established data collection tools. The study proceeded through four stages: assessment, planning, implementation and evaluation.

Assessment Phase: A brief explanation of the study's goals by the researchers along with an introduction was first given to the studied patients. Each patient was seen separately for about 30 minutes to assess his/her personal data, medical history and knowledge assessment through structured interview questionnaire (Tool I), then the researchers assessed upper limb function using FMAUE (Tool II), Brunnstrom stages assessment (Tool III), MAS (Tool IV). Daily living activities were assessed using the Barthel ADL Index Scale (Tool V). The researchers assisted patients by reading the questions to help them complete the assessment.

Planning Phase: Using the information gathered throughout the assessment phase, the researchers reviewed pertinent literatures, designed educational training program about exercises based mirror therapy and created an educational booklet with illustrations in simple Arabic language. The number of sessions, their contents, different teaching strategies and the instructional media were also determined. The goal of the exercises based mirror therapy program was to help stroke patients improve limb function and their daily living activity.

Implementation phase:

Through instructive sessions, the implementation phase was completed. It was divided into two sessions. Theoretical and practical sessions each one lasted between Twenty and Thirty-five minutes. The patients

divided into groups contained (2-4 patients), total number of groups (20).to acquire the related information.

Every session commenced with a review of the goals and objectives from the previous session, conducted in Arabic to accommodate the educational background of the patients.

During the session, encouragement and reinforcement were used to boost motivation for sharing. In addition, a comment was given and questions were answered. After being completed, the educational program was distributed to each patient.

Session 1(Theoretical): At the outset of this session, the researchers provided introduction of themselves, discussed the educational program, its significance and elaborated on its goals. The session covered topics such as understanding the definition of stroke, exploring its causes, types, risk factors, clinical manifestations, methods of diagnosis, complications of disease, methods of treatment and explain exercises based mirror therapy technique. This session took 35 minutes.

Session 2 (Practical): Begin mirror therapy exercises by seating the patient comfortably in a chair, with both arms resting on a table. One arm is placed inside a mirror box, hidden from view, while the unaffected arm is positioned in front of the mirror so that its reflection appears as the affected arm. The mirror box is placed at the patient's midline. A mirror therapy exercise is applied for 30 minutes daily for four weeks. For the first ten minutes, the patients engaged in a variety of physiological movements, such as finger counting, forearm supination and pronation, elbow flexion and extension at the edge of the table, and object-related movements, all while being observed in a mirror reflection by researchers .Then Patients squeeze sponges, move their wrists in a bold manner, slide towels across tables, transfer beans with spoons and type on a keyboard for the next twenty minutes.

Evaluation Phase:

During the evaluation phase, a reassessment was conducted to evaluate the effect of exercises based mirror therapy for four weeks on upper limb functional activity among stroke patients. This evaluation used various data collection instruments (Tools II, III, IV, and V) after the intervention.

Statistical analysis of the data:

The data underwent collection, coding, digitization, tabulation and analysis using f the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, version 21). Descriptive statistics, as mean, SD, frequency and percentages were applied. Statistical analyses encompassed the Spearman correlation test (r) to establish correlations between the upper limb functional impairment, the resistance experienced during passive range of motion and activity of daily living score of the studied sample across the study phases. The Chi-square test was used for the number and percentage distribution and the Paired (t) test was applied to compare mean scores within the same sample across different study phases. Significance levels were defined as highly significant for $p \leq 0.001$, significant for $p \leq 0.05$ and not significant for $p > 0.05$.

Results:

Table 1 shows the frequency and percentage distribution of the studied patients based on their personal and medical data. It indicates that 63.49% of the patients were over 40 years old with the mean age of 54.12 ± 6.32 years. Additionally, 74.61% were males, 60. 32% were married, regarding residence 71.42% of them were from rural areas. Also, 46.05% of them had secondary education, 39.68% of them were employees and 76.19% of them were living with family. As well 77.77% of them had ischemic stroke, 79.63% had right side paralysis and 60.32% of them had first time episodes of stroke.

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Figure 1 illustrates a comparison of the total patients' knowledge levels before and after the implementation of exercises-based mirror therapy. The figure indicates that prior to the implementation of exercises-based mirror therapy, 84.13% of studied stroke patients had an unsatisfactory knowledge score. However, after the implementation, 95% of patients achieved a satisfactory knowledge level. This suggests an improvement in the overall mean knowledge score, with a significant difference (P<0.001).

Figure 2 indicates that according to the Brunnstrom stage of stroke patients, prior to the adoption of exercises based mirror therapy, 25.3% of patients were in grade two, 31.7% were in grade three, 23% were in grade four and 20% were in grade five. After exercises based mirror therapy implementation, 14.28% of stroke patients attain grade two, 20.6% attain grade three, 31.7% reach grade four and 33.42 % attain grade five. An improvement in the Brunnstrom grades post implementation was also revealed.

Table 3 displays a statistically significant rise in the overall mean score of the studied patients' motor function of upper limb (FMA) following the adoption of exercises based mirror therapy, indicating improved motor function at p value = 0.000.

Table 4 elucidates the rise in the overall mean score of the Modified Ashworth Scale following the application of exercises-based mirror therapy, showing a significant statistical difference compared to the pre-intervention level with P=0.000 .

Table 5 shows increase in the overall mean score of daily living activities for the stroke patients at two different stages with statistical significance difference after exercises based mirror therapy implementation. That means improvement of ADL of studied patients.

Table 6 Shows that after exercises based mirror therapy implementation, a statistically significant positive correlation was revealed in overall Fugl Meyer assessment, Modified Ashworth Scale and activity of living score (Barthel index scale) among stroke patients.

Table (1): Frequency and percentage distribution of the studied patients' personal and medical data (n=63).

| personal and medical data	Items	Studied patients (n=63)	
		N	%
Age	− 30- 45 years	23	36.51
	- 45 -60 years	40	**63.49**
X ± SD		54.12 ± 6.32	
Gender	−Male	47	**74.61**
	−Female	16	25.39
Marital status	-Un married	25	39.68
	−Married	38	**60.32**
Residence	−Rural	45	**71.42**
	−Urban	18	28.57
Level of education	−cannot read and write	6	9.52
	-Read and write	9	14.28
	−Primary	9	14.28
	−Secondary	29	**46.05**
	−University	10	15.87
Occupation	−Not work	15	23.80
	−Worker	11	17.46
	-employee	25	**39.68**
	−Retirement	12	19.06
Living status	-live alone	15	23.80
	-With family	48	**76.19**
Lesion type	-Ischemic	49	**77.77**
	-Hemorrhagic	14	22.23
Affected side	-Right	**50**	**79.63**
	-Left	**13**	**20.37**
No. of stroke episodes	-First time	25	**60.32**
	-Continuous	38	39.68
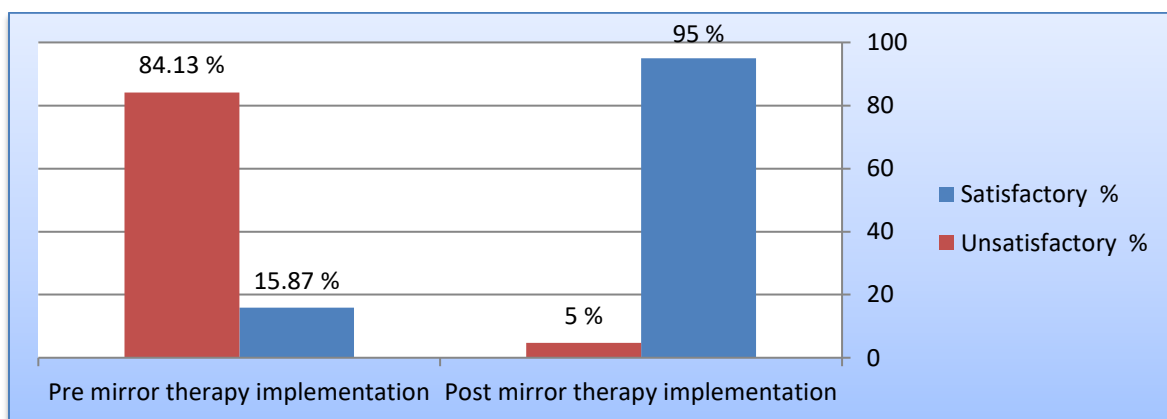
Figure (1) Comparison of studied patients' total knowledge score pre and post exercises based mirror therapy implementation.

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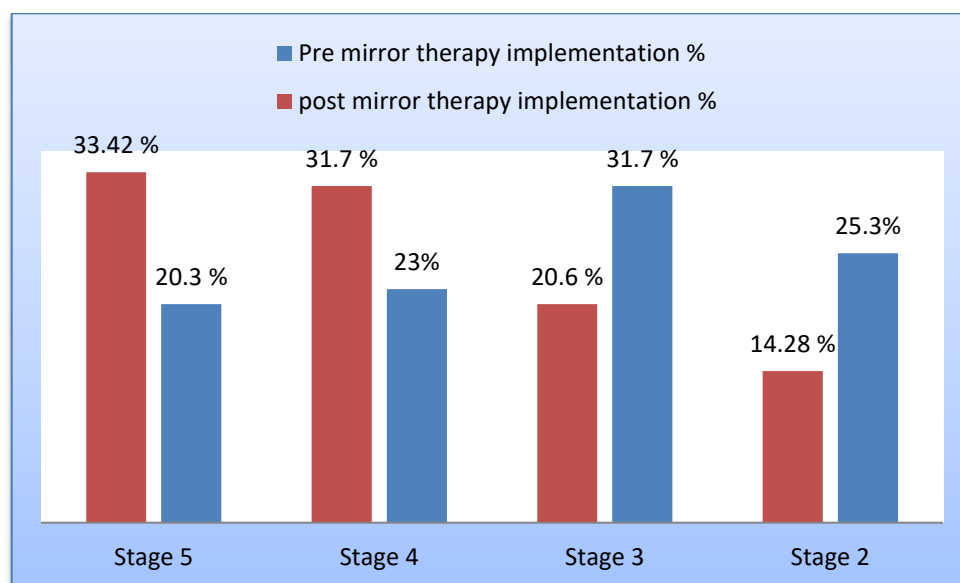

Figure (2) Comparison between mean score of Brunnstrom stage among stroke patients pre and post exercises based mirror therapy implementation (n=63)

Table (3) Comparison between mean score of upper limb motor function among studied patients pre and post exercises based mirror therapy implementation (n=63)

FMA	Pre intervention	Post intervention	T – test p- value
	X ± SD	X ± SD	
Upper limb score	17.851±8.583	24.287±11.045	T:19.735 P =0.000**
Wrist score	10.269±0.745	15.825±1.040	T:69.790 P =0.000**
Hand score	11.615±0.993	14.095±1.043	T:156.001 P =0.000**
Coordination and speed score	14.737±8.063	20.095±1.046	T:48.941 P =0.000**
Total motor function score	**54.022±8.363**	**74.302±10.986**	**T:43.272 P =0.000****

(*) Statistically significant at p<0.05.   (**) highly statistically significant at p<0.001.

T (P) between pre and post mirror therapy implementation

Table (4) Comparison between total mean score of Modified Ashworth Scale (MAS) among stroke patients pre and post exercises based mirror therapy implementation (no=63)

Item	Pre mirror therapy implementation	Post mirror therapy implementation	T – test* p- value
	X ± SD	X ± SD	
Total score of Modified Ashworth Scale (MAS)	**27.079±5.555**	**32.841±7.575**	T:37.765 P=0.000

(*) **T (P) between pre and post mirror therapy implementation.**

Table (5) Mean score of daily living activities among stroke patients pre and post exercises based mirror therapy implementation (n=63)

Barthel Index Scale Items	Pre mirror therapy implementation	Post mirror therapy implementation	T – test p- value
	X ± SD	X ± SD	
Bowel	1.80 ±0.57	2.94 ± 0.95	T : -7.97 P<0.001
Bladder	2.080 ± 0.63	2.92 ± 0.67	T :- 6.52 P<0.001
Grooming	2.12 ± 0.59	2.82 ± 0.78	T: - 4.31 P<0.001
Toilet use	2.18 ± 0.60	3.02 ± 0 .80	T: - 5.73 P<0.001
Feeding	2.24 ± 0.59	2.778 ± 0.93	T: - 3.84 P<0.001
Transfer	2.18 ±0.56	2.76 ± 0.80	T: - 4.225 P<0.001
Mobility	1.90 ± 0.61	2.88 ± 1.61	T: - 6.018 P<0.001
Dressing	2.080 ±0.67	2.96 ±0.67	T: - 5.48 P<0.001
Straits	2.04 ± 0.60	2.86 ±0.83	T: - 5.55 P<0.001
Bathing	1.90 ± 0.094	2.86 ±0.93	T: - 5.94 P<0.001
Total	**20.52 ± 3.58**	**28.80 ± 6.72**	**T: - 7.58 P<0.001**

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Table (6) Correlation between total Fugl Meyer Assessment, Total Modified Ashworth Scale and Total Barthel Index scale among stroke patients post exercises based mirror therapy implementation (no=63)

Variables	Total Fugl Meyer Assessment	
	R	P
Total Modified Ashworth Scale	.255	.044*
Total Barthel index scale	.322	.010*

Discussion:

Stroke often leads to various disabilities, significantly impacting a person's life. Upper limb paralysis, a frequent consequence of stroke, stands out as one of the most debilitating challenges for patients (**Aly & Shaheen, 2021**). Consequently, the extent of functional recovery in the upper limb plays a crucial role in determining the level of assistance required for performing daily living activities and the feasibility of achieving independence following a stroke (**Gandhi et al., 2020**).

The findings of this study indicate that approximately two-thirds of the participants were aged above 40 years, with a mean age of 54.12 ± 6.32. Furthermore, three-quarters of the participants were males and nearly two-thirds were married. In terms of residence, nearly three-quarters hailed from rural areas. Additionally, close to half of the participants had completed secondary education, around forty percent were employed and three-quarters lived with their families. Most notably, the majority of participants experienced ischemic stroke had right side paralysis and about two thirds of them had continuous episodes of stroke.

These findings are align with **Maharem et al. (2022),** who studied the mirror therapy effect on the motor and functional skills of upper extremity among chronic stroke patients. Their study revealed that the participants' mean age was 50.33 ± 11.78 years and a majority (70%) resided in rural regions. In terms of paralysis location, 60% of patients experienced right-sided paralysis, while 64% had ischemic strokes. While, contradicted regarding both sex and educational level as they indicated that 68% of the participants were females and 60% were illiterate.

The findings are agreed with those of **Panigrahi et al. (2022)** in their study about Mirror Therapy efficacy in improving the stroke patients' upper extremity Motor Function. Their research revealed that 42.5% of the patients were aged 60 years and above, while 32.5% fell within the age group of 41 to 59 years.40% were in secondary education and majority were employed and married. 52.5% of patients had ischemic stroke and 55% of them had right upper limb side affected with stroke in both groups. However, there was a discrepancy in terms of gender, as an equal number of both genders were included in both groups of the study.

Similarly, the results are in the same line with **Jaques et al., (2023)** on their study comparing the traditional Mirror Therapy vs. Immersive Virtual Reality Mirror Therapy after Stroke. They explored that majorities of

stroke group were males, ischemic and 40% of patients had experienced two or more strokes, while, contradicted regarding the paralyzed side, as left-side impairment was more prevalent. Moreover, these results agreed with those of **Solana et al. (2024)** in a study evaluated the Effectiveness of a Rehabilitation based on Cognitive Therapeutic Exercise and Mirror Therapy to Improve Upper extremity Functionality after Acute Stroke. Their results signified that 58.3% of the stroke patients were males and a significant majority (92.5%) experienced an ischemic stroke. However, there was a discrepancy regarding the affected side, as 51.7% had paralysis in the left upper limb.

Regarding the patients' understanding of stroke and exercises based mirror therapy; the findings of this study indicate that before the implementation of exercises based mirror therapy, most of the participants had inadequate knowledge. However, following the implementation, most patients achieved a satisfactory level of knowledge. This finding is indicating an enhancement in the overall mean knowledge score with (P<0.001). These results validate the first research hypothesis, demonstrating the efficacy of the exercises based mirror therapy and showing that patients' knowledge increases when information is presented in an understandable manner.

These findings are align with **Al-masaeed et al. (2021)**'s finding, which aimed to evaluate the impact of mirror therapy on motor function of extremities and daily activities among stroke patients. The study indicated that a significant number of individuals lacked sufficient information regarding the advantages of mirror therapy. The current study could contribute to enhancing patients' understanding of this therapy, thereby potentially improving movement in affected limbs and facilitating self-care among patients.

According to the Brunnstrom stage of stroke patients, the study results showed that, prior to the adoption of exercises based mirror therapy, one quarter of patients were in stage two, nearly one third of them were in stage three, nearly one quarter of them were in stage four and one fifth were in stage five. After exercises based mirror therapy implementation, more than one tenth of stroke patients attain stage two, more than one fifth attain stage three and about one third reaches stage four and stage five. According to the current results, there was a noted enhancement in the Brunnstrom grades following the implementation of exercises-based mirror therapy.

These findings agreed with **Maharem et al.'s study (2022),** which observed that among patients with chronic stroke, over half were in stage 4 of the Brunnstrom scale, while more than one-third was in stage 5. Additionally, they observed a significant correlation between the functional and motor skills of the upper extremities before and after mirror therapy implementation (p=0.001). This observation is further supported by **Arfianti et al. (2022),** who conducted a randomized controlled trial to assess the addition of mirror therapy for improving independence levels and upper limb motor recovery post-stroke. Their study found that the group receiving mirror therapy demonstrated a notable enhancement in Brunnstrom scores compared to the control group after five weeks of mirror therapy.

The results of this study demonstrates a statistically significant rise in the overall mean score for motor function following the adoption of exercises based mirror therapy, indicating improved motor function at p value = 0.000. The present study's results also

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showed a statistically significant increase in the mean score of the Fugl-Meyer Assessment (FMA) after mirror therapy exercises were implemented, with a statistically significant difference seen between the pre- and post-implementation periods. The researchers concluded that this points to mirror therapy exercises having a beneficial effect on stroke patients' FMA scores. These findings provide support for the second research hypothesis.

This discovery agreed with **Thieme et al. (2019),** whose randomized controlled trial evaluated the impact of mirror therapy exercises on arm paresis post-stroke. Their findings demonstrated that implementing mirror therapy improve Fugl-Meyer Assessment (FMA) scores, as evidenced by the consistent upward trend observed in FMA scores throughout the study period.

Furthermore, **Michielsen et al. (2020)** highlighted that stroke patients in the mirror therapy group exhibited a significant higher upper extremity Fugl-Meyer Assessment (FMA) score, attributing this outcome to the provision of suitable visual input to compensate for diminished sensory input in the affected limb. Similarly, **Small and Solodkin (2020)** documented a significant enhancement in FMA scores for the upper extremity among stroke patients in the mirror therapy group. Additionally, **Nelakurthy et al. (2021)** emphasized that using mirror therapy has enhance motor functions of upper extremity in stroke patients.

Moreover, **Panigrahi et al. (2022)** observed a statistically significant differences between the experimental and control groups both pre and post application of mirror therapy, with the experimental group displaying significantly higher mean scores compared to the control group (p=0.000). This finding suggests that mirror therapy proved beneficial for enhancing motor function. Conversely,

this observation contrasts **Arfianti et al. (2022),** who states that no significant difference in development of Functional Independence Measure (FIM) scores after five weeks of intervention with mirror therapy exercises.

The findings of this study demonstrate a notable rise in the overall mean score of the Modified Ashworth scale following the employment of mirror therapy exercises, with a statistically significant difference compared to the pre-intervention level. This finding supports the third research hypothesis. This outcome is in line with **Shaker et al. (2020),** who observed a statistically significant improvement in active range of motion of forearm elongation, wrist extension and hand function based on the Modified Ashworth Scale (MAS) and strength of the affected side following mirror therapy, particularly in the study group.

This outcome is consistent with the research conducted by **Maharem et al. (2022),** who found that mirror therapy significantly improved upper extremity functional and motor skills in patients with stroke both before and after it was implemented. This was especially true when it came to the Modified Ashworth Scale (MAS). Forearm supination, elbow extension, shoulder flexors, extensors, abductors, adductors and external rotators were all observed to be improved. Also, **Thieme et al. (2019),** who verified a notable shift in resistance to passive motions in the finger flexor muscles, corroborate this conclusion.

The result of this study clarifies the increase in the total mean score of Barthel index (ADL) among stroke patients with statistical significance difference after mirror therapy implementation. That means improvement of ADL of studied patients. Which was

supporting the fourth research hypothesis denoting to the sustained positive effect of exercises based mirror therapy on functional ability and daily living activities among stroke patients.

This result is agreed with **Bhasin et al. (2018),** who described an improvement in upper limb functional capacity and daily living activities among 30 stroke patients participating in a mirror therapy program. Also, **Maharem, et al., (2022)** indicated improvement of the motor skills of upper extremities of studied stroke patients compared to pre mirror therapy implementation.

Furthermore, these outcomes concurred with those of **Song and Park (2019),** who discovered that mirror therapy improves upper extremity functions in ischemic stroke patients. In a similar vein, **Thieme et al. (2019)** saw notable improvements in motor function in all three groups after examining the effects of mirror treatment on sixty sub-acute stroke patients who were split into individual, group mirror therapy and virtual therapy control groups.

The results align with **Wen et al. (2022); Madhoun et al. (2020),** who demonstrated significant improvements in the overall limb functionality, motor, and sensory functions through mirror therapy. These studies show that mirror therapy interventions lead to higher FMA-UE scores, enhancing upper limb functionality and motor skills, which subsequently improve daily living activities and motor function. This supports the scientific notion that, while the exact mechanism by which mirror therapy enhances motor function is not fully understood, it is proposed that mirror therapy stimulates interaction between the healthy and impaired brain hemispheres. This interaction activates relevant brain regions and promotes cortical neural network reconstruction, thereby modifying cortical excitability and facilitating functional recovery.

Daily living activities are essential tasks that individuals must perform daily to survive and adapt to their environment. In this study, mirror therapy was utilized to enhance fine motor skills in the fingers, wrists, elbows and shoulders of patients. These skills are crucial for ADLs, such as eating and dressing. By improving upper limb function, mirror therapy can also enhance the ADL abilities of post-stroke patients.

The result of this study reveals a statistically significant positive correlation between total Modified Ashworth Scale, Fugl Meyer assessment, and activity of daily living score after exercises based mirror therapy implementation. This result is supported by **Small and Solodkin (2020),** who found a significant enhancement in FIM scores in the intervention group compared to the controls after five weeks. Similar to this, **Arfianti et al. (2022)** found that after ten sessions, the mirror treatment group significantly outperformed the study group in terms of upper limb motor recovery (as shown by changes in Brunnstrom grades) and increased levels of independence (as shown by changes in FIM self-care) compared to the controls.

The findings of the present study support the fourth research hypothesis, suggesting that stroke patients who undergo mirror therapy are likely to experience improved functional ability in their upper limbs compared to their pre-therapy state. This outcome aligns with the results of **Stevens and Stoykov (2020),** who noted that mirror therapy, a form of visually induced motion illusion, involves mentally performing movements without actual physical execution

Conclusion:

Concluding on the above findings, it can be deduced that exercises incorporating mirror therapy are effective in training stroke

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patients to enhance upper limb functional activity.

Recommendations:

1-Educational materials including handouts, posters and booklets should be available for all patients with stroke to increase their knowledge regarding exercises based mirror therapy either in department of psychiatry and neurology or at outpatient clinics.

2. Conducting further researches with larger probability sample sizes under identical conditions could offer conclusive evidence on the efficacy of mirror therapy among patients with stroke.

3-More randomized controlled trials must be conducted in the area of stroke rehabilitation.

4- Conducting additional research using exercises-based mirror therapy, to examine the underlying mechanisms of motor recovery in stroke patients.

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فعالية التمارين المعتمدة على العلاج بالمرآة على النشاط الوظيفي للأطراف لدى مرضى السكتة الدماغية

صفاء محمد حامد ـ ابتسام سعد سليمان ـ دعاء محمد محمود

السكتة الدماغية هي مشكلة صحية خطيرة تؤدي إلى إعاقات حركية ووظيفية تتطلب رعاية مستمرة. وهو السبب الرئيسي للإعاقة والسبب الثاني للوفاة في جميع أنحاء العالم. العلاج بالمرآة هو علاج بديل ناشئ يتميز بالبساطة والفعالية من حيث التكلفة والتركيز على المريض. لذا هدفت الدراسة إلى تقييم فعالية التمارين المعتمدة على العلاج بالمرآة على النشاط الوظيفي للأطراف لدى مرضى السكتة الدماغية. و تم استخدام تصميم بحث شبه تجريبي (اختبار قبلي/بعدي) على عينة غرضية مكونة من 63 مريضًا تم تشخيص إصابتهم بالسكتة الدماغية وتم قبولهم في قسم النفسية والعصبيه والعيادات الخارجية في مستشفى بنها الجامعي، محافظة القليوبية، مصر. استخدمت الدراسة الأدوات التالية، الاولى: استبيان المقابلة المنظمة للمرضى، الثانية: تقييم الأطراف العلوية، الثالثة: تقييم مراحل برونستروم، الرابعة: مقياس أشوورث المعدل والخامسه: نشاط بارثيل في الحياة اليومية . أظهرت النتائج تحسنا إحصائيا ملحوظا في متوسط درجات معرفة المرضى بشكل عام بعد تنفيذ تمارين تعتمد على العلاج بالمرآة. هناك تحسن ذو دلالة إحصائية في القدرة الوظيفية الشاملة للأطراف العلوية ، حيث بلغ متوسط الدرجات الإجمالية 54.022 ± 8.363 والتي زادت إلى 74.302 ± 10.986 بعد تنفيذ التمارين المعتمدة على العلاج بالمرآة. كان متوسط الدرجات الإجمالية لمقياس نشاط بارثيل في الحياة اليومية قبل التنفيذ 3.58 ± 20.52 لكنه تحسن بشكل ملحوظ إلى 28.80 ± 6.72 بعد التنفيذ، مما يشير إلى تحسن انشطة الحياة اليومية كما خلصت الدراسة بأن العلاج بالتمرينات المعتمدة على المرآة فعال في تحسين النشاط الوظيفي للأطراف العلوية لدى مرضى السكتة الدماغية. واوصت الدراسة بأنه يجب على مرضى السكتة الدماغية أن ينظروا إلى العلاج بالتمرينات المعتمدة على المرآة باعتباره نهجًا عمليًا يسهل الوصول إليه لتعزيز وظائف الطرف العلوي.