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THE IMPACT OF STRETCHING EXERCISES WITH MIRROR THERAPY ON UPPER LIMB MOTOR FUNCTION AMONG PATIENTS WITH STROKE

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Abstract

Background: Stroke is one of the most common and overwhelming disorders that remains the second-leading cause of death and the third-leading cause of death and disability, with approximately 80% of stroke survivors have upper limb motor impairment. Stretching exercises and mirror therapy are a vital aspect of rehabilitation for improving motor recovery and preventing complications. **Aim:** was to evaluate the impact of stretching exercises with mirror therapy on upper limb motor function among patients with stroke. **Research design:** A quasi-experimental, pretest-posttest, nonequivalent control group design was used. **Sample:** 60 adult male and female patients with a confirmed diagnosis of stroke for the first time were enrolled. **Tools:** In the current study three tools were used, I. Personal and Medical Data Form (PMDF); II. Fugl-Meyer Assessment of the Upper Extremity (FMA-UE) and III. Glasgow Coma scale (GCS). **Results:** At baseline, pre-intervention showed no statistically significant differences between the study group and control group with regards all study variables. While, there is statistically significant difference with higher FMA-UE mean score between the study group and control group through intervention period; after two weeks (35.03 ± 7.53,17.00 ± 6.02), after four weeks (50.17 ± 8.82, 26.53 ± 7.32) and after eight weeks (58.50 ± 6.74, 36.33 ± 8.24) respectively. **Conclusion:** The combination of stretching exercises with mirror therapy significantly improved upper limb motor function. **Recommendation:** Replicate the study to assess effect of the intervention in other stroke stage.

Keywords: Stretching Exercises, Mirror Therapy, Stroke, Upper Limb Motor Function and Nursing Role.

1. INTRODUCTION

Stroke remains a leading global cause of mortality and long-term adult disability, constituting a significant public health challenge. It is a cerebrovascular event characterized by an abrupt interruption of cerebral blood flow, leading to rapid neuronal cell death (Caplan, Simon, & Hassani., 2023). A predominant and debilitating consequence for approximately 80% of patients is upper limb motor impairment, in form of hemiparesis, which subsequently negatively affect self-sufficiency and quality of life (Liu *et al*., 2024; Řasová *et al*., 2024). This deficit manifests as muscle weakness or contracture, changes in muscle tone, joint laxity, and impaired motor control.

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These impairments induce disabilities in common activities such as reaching, picking up objects, and holding onto object and consequently affect the ability to perform activities of daily living and quality of life (Martino Cinnera *et al*., 2024).

The recovery of patients' motor function mainly depends on rehabilitation training that aimed to restore upper extremity function, which is critical for patient autonomy. There are several rehabilitation techniques that used to improve upper limb motor function after stroke such constraint induced movement therapy (CIMT), music therapy, mental practice, movement observation, electrical stimulation methods, robotic therapy, virtual reality and exercises. However, there are many different types of exercises, for example, strengthening exercise, resistance exercise as well as stretching exercise and mirror therapy (Pan *et al*., 2021; Ceylan *et al*., 2023).

Among these interventions, mirror therapy (MT) and stretching exercises have emerged as particularly promising, accessible, and cost-effective modalities. Mirror therapy is a non-invasive technique that utilizes visual feedback; by observing the reflection of the unaffected limb moving, the brain is tricked into perceiving normal movement in the paretic limb. This technique has shown promise in facilitating motor recovery and promoting neural plasticity in stroke patients (Kim *et al*., 2023). Concurrently, stretching exercises are a fundamental component of rehabilitation, aiming to improve range of motion, reduce muscle stiffness and spasticity, and prevent contractures (Gomez-Cuaresma *et al*., 2021).

Emerging evidence suggests that these two therapies may have a synergistic effect. A randomized controlled trial by Shoaib et al. (2023) demonstrated that patients receiving a combined intervention of mirror therapy and conventional therapy exhibited significantly greater improvements in upper limb function and daily living activities compared to those receiving conventional therapy alone. Moreover, study by Nadatien, Salamah, & Hidaayah (2024) reported that the combination exercise technique of mirror therapy and ROM is able to increase muscle strength and physical mobility in stroke patients, thus helping to restore limb function lost due to stroke.

The management of stroke requires a multidisciplinary approach, acute medical management focuses on minimizing initial brain damage, comprehensive rehabilitation is paramount for functional recovery. Nursing professionals play a pivotal and multifaceted role, from the acute phase onward, nurses are involved in conducting rapid neurological assessments using standardized scales like the NIHSS, pupillary response and cranial nerve assessment, monitoring vital signs, administering prescribed thrombolytics, and preventing medical complications such as aspiration pneumonia and deep vein thrombosis, is essential to optimize recovery, reduce the risk of recurrent strokes, and improve overall outcome (Lyttle & McGranaghan, 2024). Beyond acute care, nurses serve as primary coordinators of long-term rehabilitation, providing patient and family education, facilitating therapy adherence, and continuously evaluating functional progress. Therefore, the aim of this study is to evaluate the impact of stretching exercises with mirror therapy on upper limb motor function among patients with stroke.

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Significance of the Study

Stroke represents a leading cause of global disability, with approximately 80% of patients experiencing permanent motor impairment. Upper limb (UL) dysfunction is particularly prevalent, affecting up to 85% of patients initially and persisting in 55-75% of cases at 3-6 months post-stroke, ultimately it led to diminish independence in activities of daily living and quality of life (Martino Cinnera, Picerno, Bisirri, Koch, Morone, & Vannozzi, 2024). In Egypt, according to WHO (2024) stroke is one of top ten causes of death. As well, stroke prevalence is notably high (963/100,000 inhabitants), with an annual incidence of 150,000-210,000 cases (Aref *et al*., 2021; Roushdy *et al*., 2025).

Clinical observations consistently demonstrate the profound impact of UL weakness on stroke survivors' lives, particularly regarding difficulties with self-feeding, hygiene maintenance, and reduced independence in basic activities. Most of recent researches utilized mirror therapy as new rehabilitation modalities to improve UL motor function, either as a standalone intervention or combined with technologies like virtual reality but until now there is scanty research conducted on static stretching exercise combined with mirror therapy among patients with stroke to evaluate its effect on upper limb motor function. Hopping, the anticipated findings of the current study that combined static stretching exercise with mirror therapy may benefit nurse practitioners through providing a valuable information about stretching exercise as an alternative neuro-rehabilitation techniques among patients with stroke that may improve motor function, enhance patients' abilities, increase quality of patient's care and consequently prevent extra costs. Also, it is hoped that this finding might be helpful for further researches in this area and establish evidence-based data that can enhance nursing practice and research.

2. METHODS

2.1 Aim

The current study aimed to evaluate the impact of stretching exercises with mirror therapy on upper limb motor function among patients with stroke.

2.2 Research Hypothesis

H: The post total mean scores of upper limb motor function for patients with stroke who will practice stretching exercises with mirror therapy will be different from the post total mean scores of upper limb motor function for patients with stroke who will receive routine hospital care.

2.3 Research Design

A quasi-experimental, pretest-posttest, nonequivalent control group design was utilized to achieve the aim of the current study.

2.4 Setting

This study was conducted in the Neurology Department as well as the Neurology Outpatient clinic affiliated with Al -Kasr Al -Aini University Hospitals, Cairo, Egypt.

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2.5 Sample

A convenient sample of 60 adults, with a confirmed diagnosis of stroke for first-time and having unilateral hemiparesis (within 24-48 hours of stroke onset) was recruited within one year; with age from18-65 years, GCS score of 15, and having ischemic or hemorrhagic stroke. While the participants with peripheral neuropathy, comorbid neurological and orthopedic diseases in upper extremity were excluded.

2.6 Tools

Data was collected using the following three tools:

Tool (1): Personal and Medical Data Form (PMDF). It was developed by the researcher based on extensive literature review and consists of two parts; part I: includes, patient's personal data such as age, gender, marital status, level of education, employment status, place of residence and living status. while, part II: delineated medical data such as medical diagnosis, affected side, smoking status, any associated chronic diseases and family history.

Tool (II): Fugl-Meyer Assessment of the Upper Extremity (FMA-UE). The Fugl-Meyer Assessment for the Upper Extremity (FMA-UE) is a widely recommended and reliable scale for assessing sensorimotor function in post-stroke patients. For the purpose of this study, only the motor function section was utilized. This section comprises 33 items assessing movement, coordination, and reflex action of the upper extremity, wrist, and hand. Each item is scored on a 0-2 scale, with total score ranging from 0 to 66 points, the higher scores indicating better motor function. Total scores are interpreted as follows: severe (0-15), severe to moderate (16-34), moderate to mild (35-53), and mild impairment (54-66). The FMA-UE demonstrates high reliability, with an intraclass correlation coefficient (ICC) of 0.96 for the upper extremity subsection (Fugl-Meyer *et al*., 1975; Wen *et al*., 2022).

Tool (III): Glasgow Coma scale (GCS). The Glasgow Coma Scale (GCS) was used to assess the consciousness level of the participants. This standardized tool evaluates three aspects of responsiveness: eye opening (E), verbal (V), and motor (M) responses. Scores range from 1 (no response) to 4 (eye response), 5 (verbal response), and 6 (motor response), with a maximum total score of 15 indicating full consciousness. Consciousness levels were classified as follows: mild disturbance (13–14), moderate disturbance (9–12), and severe disturbance (3–8). The scale demonstrates good inter-rater reliability (p = 0.86) (Jain & Iverson., 2023; Physiopedia., 2022).

3. VALIDITY AND RELIABILITY

Content validity of the study tools was reviewed by a panel of three experts from Faculty of Nursing, Cairo University. The experts were asked to examine the instruments for content coverage, clarity, wording, length, format, and overall appearance. On the other hand, reliability of Arabic version of FMA-UE was tested statistically using test-retest reliability method = 0.91.

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4. ETHICAL CONSIDERATION

Final approval was obtained from the Research Ethics Committee of Faculty of Nursing, Cairo University (IRB:2019041701).

Also, an official permission was obtained from hospital/unit administrators to conduct the study. Each patient was informed about the nature, purpose and significance of the study.

Also, patients were informed that participation in the study is completely voluntary, as well as they have the right to withdraw from the study at any time without any effect on the routine care.

Safety principles and guidelines that guarantee the health and safety of the patients while performing range of motion exercises were also taken into consideration by the researcher.

Additionally, all participants were informed that their anonymity and confidentiality will be assured through coding the data and the data will not be reused for any other research without their permission. Patients who are willing to participate in the study were asked to sign the consent form.

5. PROCEDURE

During the preparatory phase, all data collection tools and necessary equipment were prepared. An illustrated Arabic booklet containing exercise instructions, along with educational information about stroke, was developed for participants.

Eligible hospitalized patients were screened using the PMDF (Tool I) and GCS (Tool II). Those who meeting inclusion criteria received detailed explanations about the study purpose and procedures. Informed consent was obtained from all participants or the first-degree relatives if the dominant hand was affected, with two witnesses present.

In implementation phase, data collection started with the control group to prevent contamination; these participants received only routine hospital care, including nursing care and electrical stimulation. Subsequently, the study group was enrolled.

Baseline assessments for both groups were conducted using the Personal and Medical Data Form (PMDF), Fugl-Meyer Assessment of the Upper Extremity (FMA-UE), and Glasgow Coma Scale (GCS).

Patients in the study group received individualized training in stretching exercises combined with mirror therapy, supported by the illustrated Arabic booklet.

The intervention was conducted three times daily, in the morning shift the exercise performed passively by researcher, in afternoon shift the patients performed the exercise under the researcher guidance, and in the night shift the patients performed the exercise independently using the Arabic booklet as a guidance. This procedure continued until hospital discharge.

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Intervention Procedure. The mirror therapy intervention followed a standardized protocol adapted from Nogueira *et al*., (2021).

Each session began with the researcher ensuring that the patient had removed all jewelry, rings, watches and any accessories then positioned comfortably in bed or a wheelchair with adequate back support.

Patients were positioned facing a mirror placed on a table next to the unaffected arm. The affected arm was covered with a sheet while the unaffected arm was positioned in front of the mirror.

Patients performed static stretching exercises with the unaffected limb, including shoulder (abduction, adduction, internal and external rotation, flexion, and extension), elbow (flexion and extension), forearm (supination and pronation), wrist (flexion and extension), and finger movements (flexion, extension, abduction, and adduction).

During these movements, patients focused on the mirror image, creating the visual illusion of movement in the affected limb. All joints were properly supported during movement execution.

Following the mirror therapy exercise, patients performed static stretching exercises on the affected arm. Each stretch was performed slowly to the point of tolerance, with proper joint support, and held for 30 seconds.

Rest periods of 1-2 minutes were provided as needed based on patient tolerance. The intervention session required approximately 60-90 minutes. The researcher maintained regular communication with participants and the relatives to encourage adherence and address concerns, ensuring proper technique throughout the intervention period.

Evaluation Phase. All patients from both study and control groups were evaluated using the Fugl-Meyer Assessment of the Upper Extremity (FMA-UE) (tool II) at three time points: the first (at second week), the second (at the fourth week) and the third post-intervention (at eighth week).

Follow-up assessments were conducted twice-weekly by telephone contacts and scheduled outpatient clinic visits.

6. STATISTICAL DESIGN

The collected data was scored, tabulated and analyzed using Statistical Package for Social Science program version 23 (IBM Corp,2015).

The statistical data were presented in the form of descriptive statistics such as frequency, percentage, variable means and standard deviation, in addition to, inferential statistics including independent t -test, also chi square for categorical data to identify differences between the groups.

The researcher adopted a level of significance at p value ≤ 0.05 for testing research hypothesis.

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7. RESULTS

Table 1: Personal Data of Study and Control Group (n=60) 30/ each.

Variables	Study group (n=30)		Control group (n=30)		X^2	P
	no.	%	no.	%		
Age						
18-<30	0	0.0	1	3.3		
30-<40	3	10.0	1	3.3		
40-<50	6	20.0	7	23.3		
50-<60	18	60.0	14	46.7	5.8	0.66
>60	3	10.0	7	23.3		
Mean ± SD	55.50 ± 9.28		54.83 ± 9.64			
Gender						
Male	21	70.0	17	56.7		
Female	9	30.0	13	43.3	1.2	0.54
Marital status						
Single	1	3.3	4	13.3		
Married	25	83.3	20	66.7		
Widow	3	10.0	6	20.0	7.2	0.29
Divorced	1	3.3	0	0.0		
Education						
cannot read and write	8	26.7	10	33.3		
can read and write	1	3.3	5	16.7		
Primary	1	3.3	3	10.0		
Secondary	15	`50.0	9	30.0	10.3	0.24
University	5	16.7	3	10.0		
Occupation						
non-employee	6	20.0	14	46.7		
Employee	15	50.0	7	23.3	10.9	0.2
house wife	9	30.0	9	30.0		
Place of residence						
Rural	5	16.7	6	20.0		
Urban	25	83.3	24	80.0	1.1	0.55
Living status						
Alone	0	0.0	9	30.0		
With family member	30	100.0	21	70.0	6.4	0.4
No. of family members						
1-4	23	76.7	14	66.7		
5-10	7	23.3	7	33.3	25.2	0.06

Table 1. Illustrates that the mean age of patients was 55.50 ± 9.28 years in the study group and 54.83 ± 9.64 years in the control group. Also, shows that the two studied groups were comparable in terms of age distribution, gender, education levels, marital status, place of residence occupation patterns, and number of family members ($p \geq 0.05$).

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Table 2: Medical Data of Study and Control Group (n=60) 30/ each.

Variables	Study group (n=30)		Control group (n=30)		X^2	P
	no.	%	no.	%		
Onset						
within 24hr	19	63.3	18	60.0		
within 48hr	11	36.7	12	40.0	0.27	0.87
Affected side						
left side	16	53.3	11	36.7		
right side	14	46.7	19	63.3	1.9	0.38
Smoking						
Yes	13	43.3	16	53.3		
No	17	56.6	14	46.7	1.7	0.42
Since when	n=13		n=16			
10-30	3	10.0	4	13.3		
>30	10	33.3	12	40.0	9.9	0.86
Number of cigarettes						
10-30	4	13.3	12	40.0		
>30	9	30	4	13.3	14.1	0.29
Comorbid						
Yes	14	46.8	23	76.6		
No	16	53.2	7	23.4	6.6	0.3
Types of comorbid	n=14		n=23			
Diabetes (DM)	3	9.9	8	26.6		
Hypertension (HTN)	4	13.3	8	26.6	16.8	0.26
DM+HTN	7	23.4	7	23.4		
Family history						
Yes	19	63.3	17	56.7		
No	11	36.7	13	43.3	0.66	0.71

Table 2. Shows no statistically significant differences with regard to all of variables. About stroke onset, most of patients in both studied groups experienced the stroke within 24 hours, comprising (63.3%) of the study group and (60.0%) of the control group. While, in the study group, stroke affected the left side among (53.3%) of patients, conversely, in the control group (63.3%) had right-sided. About smoking status, nearly half of patients in both studied groups were smokers, with (43.3%) in the study group and (53.3%) in the control group reporting smoking habits. Among smokers, the majority in both studied groups had smoked for more than 30 years (33.3%) in the study group and (40.0%) in the control group. The number of cigarettes smoked daily that more than 30 cigarettes per day represented 30.0% of the study group, on the other hand, 40% of the control group smoked ten to thirty cigarettes per day.

About comorbid diseases in the current study, it was highly prevalent among the control group with (76.6%), conversely (53.2%) of the study group had no comorbidities. Among those with comorbidities, combined diabetes and hypertension were the most common in both studied groups (23.4% each), followed by hypertension alone (13.3% in the study group and 26.6% in the control group). Diabetes alone represented (9.9%) in the study group and (26.6%) in the control group. In relation to family history, a positive family

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history of stroke was observed in (63.3%) of the study group and (56.7%) of the control group.

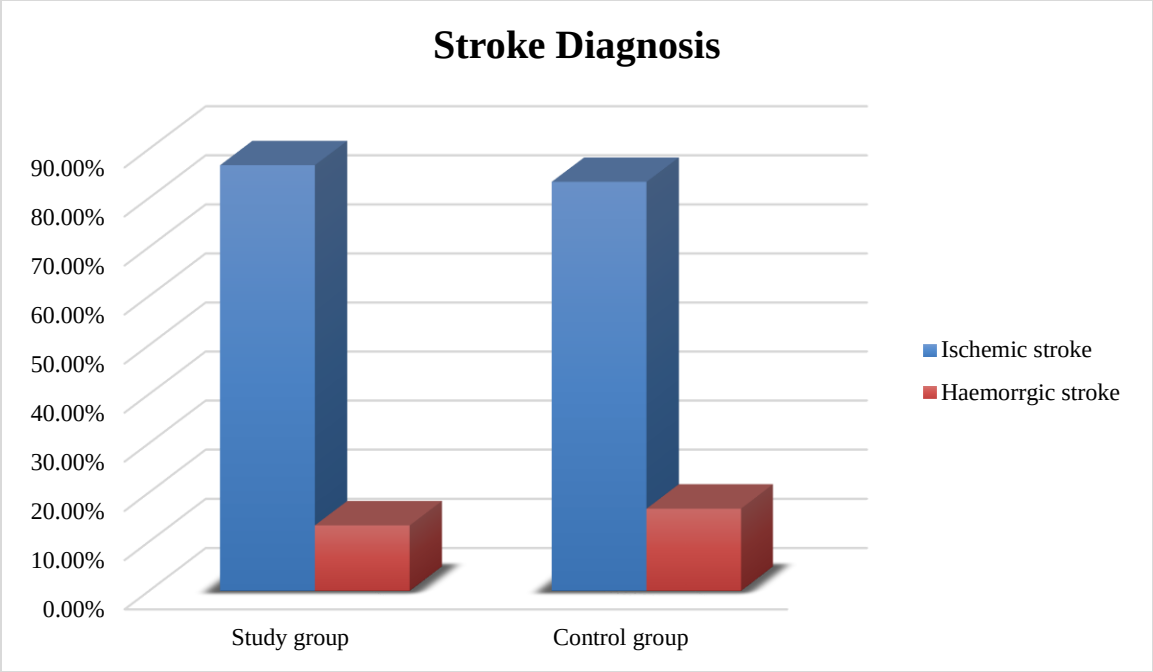

Figure 1: Frequency Distribution of Stroke Diagnosis among Study group and Control group (n= 60).

Figure 1. presented that ischemic stroke was the most prevalent type among both studied groups, comprising 83.3 in the study group, and 80 % in the control group. While, hemorrhagic stroke represented 16.7%, 20.0% respectively among the study group and control group respectively.

Table 3: Comparison of Total Mean Scores of Upper Limb Motor Function among Study and Control Groups at Baseline and Post-Intervention after two, four and eight weeks (n= 60).

Assessment Time	Study Group (n = 30)	Control Group (n = 30)	*F*	**p**
	M* ± *SD	***M* ± *SD***		
Baseline	10.00 ± 3.67	8.43 ± 4.20	1.391	0.254
Posttest 1 (After 2 weeks)	35.03 ± 7.53	17.00 ± 6.02	51.040	.000*
Posttest 2 (After 4 weeks)	50.17 ± 8.82	26.53 ± 7.32	72.502	.000*
Posttest 3 (After 8 weeks)	58.50 ± 6.74	36.33 ± 8.24	74.345	.000*

It is apparent from table (3) that there were no statistically significant differences in the total mean scores of upper limb motor function at the pre-intervention assessment time (f =1.391 & P = 0.254). However, significant differences emerged between study group and

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control group at posttest 1(35.03 ± 7.53, 17.00 ± 6.02), posttest 2 (50.17 ± 8.82, 26.53 ± 7.32) and posttest 3 (58.50 ± 6.74, 36.33 ± 8.24) at (p =0.000).

Table 4: Frequency Distribution of Upper Limb Motor Dysfunction Level among Study and Control Group (n= 60).

Time	Motor Dysfunction Level	Study Group (n=30)		Control Group (n=30)		*X2*	*P*
		no.	%	no.	%		
Baseline	Severe	27	90.0	29	96.7	4.2	0.11
	Severe to moderate	3	10.0	1	3.3		
	Moderate to mild	0	0.0	0	0.0		
	Mild	0	0.0	0	0.0		
Post 1 (2weeks)	Severe	1	3.4	12	40	38.4	0.00*
	Severe to moderate	8	26.6	18	60		
	Moderate to mild	21	70	0	0		
	Mild	0	0.0	0	0.0		
Post 2 (4weeks)	Severe	0	0.0	3	10.0	57.1	0.00*
	Severe to moderate	1	3.3	23	76.7		
	Moderate to mild	18	60.0	4	13.3		
	Mild	11	36.7	0	0.0		
Post 3 (8weeks)	Severe	0	0.0	0	0.0	48.9	0.00*
	Severe to moderate	0	0.0	11	36.7		
	Moderate to mild	4	13.3	18	60.0		
	Mild	26	86.7	1	3.3		

Table 4. Explicates that motor dysfunction level distribution among the two studied groups revealed significant differences at post-intervention assessments. While both studied groups were comparable at baseline ($\chi^2 = 4.2$, $p = .11$), the study group demonstrated significantly greater functional improvement over time. By the end of the eighth week of intervention, 86.7% of the study group achieved mild dysfunction level compared to only 3.3% of the control group ($\chi^2 = 48.9$, $p = 0.00$).

8. DISCUSSION

The current study showed that the majority of age among study group and control group fell between 50 and 60 years with the mean age ± SD 55.50 ± 9.28, and 54.83 ± 9.64 years respectively. This result is congruent with Fernández-Solana, et al., (2024), which showed that the age of the patients in the study ranged between forty-one to sixty-nine years, with the mean age 68.92 (SD = 11.79). Besides, Feigin., et al., (2025) reported that about half (53%) of all incident stroke occur in men during midlife, it is harmonized with the current study results that the majority of gender was male in study group and control group. This result is consistent with Fernández-Solana *et al*., (2024), which showed that the gender distribution was about half for males and more than one-third for females. About living status, the researcher found that the majority of patient in the studied groups were living with the family members, while one third of patients reported living alone. This is consistent with the study findings by O'Connell, Marsh, & Seydell-Greenwald (2024) reported that Twenty-four percent of participants in the sample stated

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living alone and living alone is associated with increased mortality across older age. From the researcher point of view, being with family members would rise familial/social support, this led to positive effect in patient outcome. In relation to, the marital status, more than half of the studied groups were married. Even though, less than one-third were single or divorced. This is consistent with study by Gloria *et al*., (2024) which stated that the majority were married, while the minority were single, widowed or divorced. From the researcher point of view, being married may improve health status because the presence of partner support which may improve psychosocial status, and this would enhance physical status.

Regarding educational level, the study showed that around one-third of patients in the study group and control group cannot read and write. While, approximately more than half of the patients had a primary, secondary and university-level education. These results may lead to increase patient participation and engagement which may cause more progress in patient outcome. The finding of the current study was supported by the previous study conduct by Ouyang *et al*., (2024) reported that more than three-quarters of patients had a high school education. About place of residence, more than three-quarters of the studied groups were from urban areas. This is synchronized with study findings by Bailey, & Miner, (2023) which showed that two-third of patients were urban (non-rural) and approximately one-third of patients were from rural.

Related to diagnosis of stroke, the current study showed that more than three-quarters of the study group and control group was diagnosed with ischemic stroke, while less than one-quarter diagnosed with hemorrhagic stroke in the studied groups. These results were congruent with the study by Gulzar *et al*., (2025) which support that the majority of patients 92.4% experienced ischemic stroke, while the minority experienced hemorrhagic stroke. Regarding affected side of the body, the current study findings exposed that more than half of patients in the control group had right-side weakness while in the study group about half of patients have left-side weakness. This is inconsistent with study findings by Ścisło *et al*., (2024) which informed that the majority of patients had left side hemiparesis, and the minority had right side hemiparesis. In relation to comorbid conditions, about half of the study group and about three quarter of control group have at least one comorbid disease, hypertension and diabetes been the most common, whether individually or combined. These results matched with study findings by Amar, (2024) who declared that the most common comorbidities in stroke patients are hypertension, hyperlipidemia, and diabetes. Moreover, the study by Tanlaka, Voth, & Liem, (2022) which explained that the presence of certain comorbidities (e.g., diabetes, hypertension) prior to stroke may increase the risk of stroke.

Concerning family history, in the current study more than half of patients among the both studied groups reported that there was a positive family history of stroke. This is synchronized with Błaż & Sarzyńska-Długosz, (2023) who reported that the prevalence of family history of stroke among patients with ischemic stroke ranged from 12 to 52%. As well, a positive family history of stroke is associated with a greater prevalence of risk factors for stroke and increased risk of first-time TIA and stroke.

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Relating to research hypothesis, there is no statistically significant difference in baseline upper limb motor function scores between the study and control group. But, through intervention period, the study group demonstrated significant higher mean scores on the Fugl-Meyer Assessment compared to the control group ($p \leq .05$). At baseline pre-intervention, the most of patients in both studied groups were initially presented with severe motor impairment, whereas the first, the second and the third post-intervention assessment showed significant greater improvement in upper limb motor function level among patients who received stretching exercises with mirror therapy compared to those received routine care alone. Therefore, the hypothesis was supported. There are some studies that discussed the effect of stretching exercises with mirror therapy on upper limb motor function among these patients. The current findings are compatible with study title" Effects of Mirror Therapy on Upper Limb Motor Function of Patients with Stroke: A Systematic Review and Meta-Analysis of Randomized Controlled Trials" which affirmed that most of the included studies in this review comparing mirror therapy with conventional therapy showed positive effects on upper limb motor function (Saragih *et al*., 2025). In addition, the current study findings are coordinated with study by Nadatien, Salamah, & Hidaayah (2024) who denoted that patient with stroke who undergo a combination of mirror therapy and range of motion exercises displayed a significant improvement in muscle strength, this would improve motor function.

Moreover, the findings of the current study are synchronized with the study titled "The Combination of Mirror Therapy and Range of Motion (ROM) Therapy Increased the Muscle Strength" which indicated that the combination of ROM exercises and mirror therapy in medical treatment can help in restore better exercise intensity in stroke patients. Providing mirror therapy and ROM therapy to the body areas which undergo weak or stiff joint can lead to restore muscle extent to normal, subsequently enhance motor function (Suyanto, Puspita, & Amal, 2023). Furthermore, this is study results are compatible with study by Fernández-Solana *et al*., (2024) stated that recent studies have verified that the combining of mirror therapy with other rehabilitation therapies would activate central nervous system plasticity and improve motor function more effectively than when used individually.

From the researcher point of view, the most reasonable clarification for the differences between study group and control group is applying stretching exercises with mirror therapy, addition to that, providing practical sessions for patients in the study group, while giving the patient the chance to ask questions about issues that seemed unclear or incomprehensible. Too, the illustrated booklet that was developed by the researcher and given to all participants in the study group which contain clear and concise information supported with many pictures illustrating the intervention for the study group. This is synchronized with study by Lyu, Li, & Li, (2024) who supported that the patient education should be patient-centered based on patients' assessments and needs, patient education could be delivered through face-to-face interactions to allow patients directly address the questions or concerns or written printed materials to ensure accessibility and to avoid misinformation and this matched with the intervention procedure in the current study.

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9. CONCLUSION

The study findings concluded that the combination of stretching exercise with mirror therapy had a significant effect in improving upper limb motor function among patients with stroke.

Recommendation

1) Incorporate stretching exercise with mirror therapy into the rehabilitation protocols for patients with stroke.
2) Replicate the study to assess effect of the intervention in other stroke stage.
3) Replication of the study on a large sample in different stroke setting.

Declarations

1. Ethical Considerations: This study was part of a Doctorate dissertation, approved by the Research Ethics Committee of Faculty of Nursing, Cairo University (ethics code: RHDIRB2019041701); the study number is 2024-01-11. In addition, a written informed consent was obtained from all patients after explaining the nature, purpose and significance of the study as well as the expected benefit and/or risk. It was emphasized also that the patients in the study is entirely voluntary and have the right to withdraw from the study at any point without penalty.

2. Availability of data and materials: The data that support the findings of this study are available from the corresponding author upon reasonable request.

3. Competing interests: The authors declare that they have no competing interests.

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

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