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College of Applied Medical Sciences
Department of Physical Therapy & Health Rehabilitation

The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation.

A Thesis Submitted in Partial Fulfillment of the Requirements for the master's degree in Physical Therapy

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Committee's Decision and their Signatures

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تقرير لجنة المناقشة

تأثير العلاج بالمرآة على الحركة الوظيفية للأطراف العلوية
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وئام عقاب خلف السالم

تمت الموافقة على تشكيل لجنة المناقشة والحكم على رسالة الباحثة **وئام بنت عقاب بن خلف السالم** لنيل درجة الماجستير في تخصص العلاج الطبيعي من مجلس قسم العلاج الطبيعي والتأهيل الصحي (رقم 22) بتاريخ (1444/10/17هـ) ومن مجلس كلية العلوم الطبية التطبيقية (رقم 30) بتاريخ (1444/10/27هـ) على أن تكون اللجنة من الأعضاء التالية أسمائهم:

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قرار اللجنة ومناقشة الحكم:

تميزت رسالة الطالبة بالمنهجية والأصالة والوضوح وتعتبر نموذج عملي مطبق واشتملت على العديد من النتائج والتوصيات التى تخدم المجال البحثي وتم عرض الرسالة بشكل جيد. وتوصي اللجنة بقبول الرسالة لنيل درجة الماجستير فى تخصص ماجستير العلوم في العلاج الطبيعي.

ABSTRACT

Introduction: Stroke is an acute compromise of cerebral perfusion. There are 15 million people in the world who suffer a stroke annually. The most common problem after the stroke is a weakness or paralysis of one side of the body that disrupts daily living activities (ADL). Mirror Therapy (MT) is one of the alternative therapies based on the interaction of visual proprioception inputs. **Aim:** The study aimed to determine the effectiveness of mirror therapy versus conventional physical therapy treatment in improving upper extremity impairments and motor function among chronic hemiplegic subjects. **Subjects and Method:** In this randomized controlled trial, 38 chronic hemiplegic subjects were recruited. The subjects were allocated to either control or experimental groups randomly. Both groups consist of 19 subjects. The control group received Conventional Physical Therapy (CPT) treatment for 45 minutes, whereas the experimental group received CPT treatment for 30 minutes along with 15 minutes of MT. The duration of the treatment for both groups was three sessions per week, for a period of six weeks. The initial assessment used Mini-Mental State Examination (MMSE) and the Modified Ashworth Scale (MAS). Pre- and post-intervention for upper extremity impairments and motor function were assessed using Fugl-Meyer Assessment Upper Extremity (FMA-UE) and Wolf Motor Function Test (WMFT) time and functional ability scores. **Results:** Out of 38 subjects with a mean age of 54.97 years**,** 26 were male, and 12 were female. Among these 38 subjects, 28 suffered from ischemic stroke, and 10 suffered from hemorrhagic stroke. Pre to post-intervention, the experimental and control groups have improved significantly, with a p-value < 0.01 on all three outcomes. When we compared the improvements in the experimental group to the control group, the experimental group had a statistically significant difference with p value < 0.01 on all three outcomes, that is, FMA-UE, WMFT time, and a functional ability score. **Conclusion:** Six weeks of 18 sessions of experimental group mirror therapy combined with conventional physical therapy for 45 minutes in each session had superior improvements compared to the conventional physical therapy sessions alone. The impairments assessed by the FMA-UE scale and motor function assessed by WMFT, both time and functional ability assessment scores were significantly higher in the experimental group with p value < 0.05.

Keywords: Stroke, hemiplegia, mirror therapy, upper extremity, motor function.

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WEAM OKAB ALSALEM

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WHO	World Health Organization
CVA	Cerebrovascular Accident
ADL	Activities of Daily Living
CIMT	Constraint-Induced Movement Therapy
MT	Mirror Therapy
PNF	Proprioceptive Neuromuscular Facilitation
FES	Functional electrical stimulation
CPT	Conventional Physical Therapy
MRP	Motor Re-learning Program
TIA	Transient Ischemic Attack
DVT	Deep Vein Thrombosis
ICH	Intracerebral Hemorrhage
EEG	Electroencephalogram
VR	Virtual Reality

CNS	Central Nervous System
MMSE	Mini-Mental State Examination Test
MAS	Modified Ashworth Scale
UEFI	Upper Extremity Functional Index
WMFT	Wolf Motor Function Test
BRS	Brunnstrom Recovery Scale
CT	Computerizes Tomography
MRI	Magnetic Resonance Imaging
EMG	Electromyography
VAS	Visual Analog Scale
ICF	International Classification of Functioning
FMA-UE	Fugl-Meyer Upper Extremity Assessment
ARAT	Action Research Arm Test
RCT	Randomized Controlled Trial
BAT	Bilateral Arm Training
ERD	Event-Related Desynchronization

FIM	Functional Independence Measure
MBI	Modified Barthel Index
MAL	Motor Activity Log
IRB	Institutional Review Board
KSMC	King Saud Medical City
SBAHC	Prince Sultan Bin Abdulaziz Humanitarian City
SPSS	Statistical Package for the Social Science

CHAPTER 1

1.0 Introduction

As per the World Health Organization (WHO) definition, stroke is a sudden onset of neurological disturbance due to focal or global vascular reasons. The clinical features produced last more than 24 hours after onset (Alqahtani et al., 2020). Stroke, otherwise called cerebrovascular accident (CVA), is an acute compromise of cerebral perfusion and is known as a vascular disease. Annually, there are 15 million people who suffer from stroke, which is the second most prominent reason of death and the third most known reason for disability (Bakraa et al., 2021). The burden of stroke varies in different parts of the world; in the Middle East nations, the incidence of various strokes was ranged between 22.7 and 250 per 100,000 people per year (Alhazzani et al., 2018). Whereas specifically, in the Kingdom of Saudi Arabia, the prevalence rate of stroke is 43.8 per 100,000 citizens. Saudi Arabia was developed exceptionally in the previous twenty years and evolved rapidly as a developed country due to this quick transition; there were significant lifestyle adjustments and environmental factors which caused a hike in the risk and incidence of stroke in this nation (Bakraa et al., 2021). However, researchers in various regions of Saudi Arabia have quoted varied and conflicting incidence rates of stroke, that is 15.1/100,000 individuals in Jizan, 29.8/100,000 individuals in Eastern province, and 43.8 / 100,000 persons in Riyadh (Alhazzani et al., 2018; Shaker et al., 2020).

In general, the gender distribution of stroke burden is more in men than in women, especially in either ischemic or hemorrhagic stroke types. Similar gender tendency was reported in Aseer provenance of the Kingdom of Saudi Arabia except in one age group that is 45 to 49 years, where the incidence rate among females was more than males. Globally many authors have suggested a positive correlation between age and stroke onset. Moreover, when the age pasts 25 years, the possibility of stroke is more than 25%, and after 55 years, the incidence rate is doubled in each decade. This correlation was observed in the Kingdom of Saudi Arabia. A study in Aseer provenance quoted an incidence rate as high as 851.81 per 100,000 individuals aged more than 70 years. Commonly awareness about any health condition, incidence, and risk factors potentially decrease the incidence rate. Researchers believe that the reason behind the high incidence rates of stroke among the Saudi people is due to absence of awareness in public about the risk factors of stroke (Bakraa et al., 2021).

The paralysis on one half of the body that is hemiplegia commonly results from the involvement of the cerebral cortex due to hypoxic damage or ischemic infarction, or hemorrhagic bleed. Moreover, it not only causes paralysis sometimes, but it may also lead to movement disorders due to the involvement of prominent structures in the basal ganglia (J.-H. Kim & Lee, 2017).

The damage caused by stroke is more commonly due to a focal lesion than a diffuse lesion, and clinical presentations are specific to the involved anatomical cortical areas. Based on the vascular involvement, the stroke is classified into four standard varieties: an anterior cerebral artery, middle cerebral artery, internal carotid artery, and posterior cerebral artery syndromes. Whereas depending on the duration of the stroke, it is classified as a transient ischemic attack (stroke duration < 24 hrs.) or an actual stroke (stroke duration > 24 hrs.) (Chinnavan et al., 2020).

There were many changeable and non-changeable risk factors for stroke. But the main risk factors were age, smoking, alcohol consumption, high blood pressure, history of cerebral vascular disease, lack of physical activity, diabetes mellitus, dyslipidemia, obesity, cardiovascular disease, metabolic disorders, and diet (Habibi-Koolaee et al., 2018). Stroke is believed to be preventable if living habits and other changeable risk factors are addressed on an individual or community level. (Bakraa et al., 2021).

Mortality or morbidity are consequences of the stroke where; both issues concern various societies and nations (Li et al., 2019). The most common problem after the stroke is weakness or paralysis of half of the body, which disrupts the daily life activities (ADL). Most of the time, the word hemiplegia is used as a synonym for stroke. However, the actual meaning of hemiplegia is paralysis in the one half of the body, which is especially visible in the upper and lower extremities, along with many other motor deficits (Chinnavan et al., 2020) extent of neurologic damage for an individual is determined by the place and amount of brain injury, the extent of collateral blood circulation, and how well the subject was managed in acute care immediately after stroke (Chinnavan et al., 2020).

Out of the total stroke population, 85% of people had hemiplegia, and among them, at least 69% of people had involvement in the upper extremity. The involvement of the upper limb is one of the most difficult challenges faced by subjects with stroke, especially while performing the ADL (Park et al., 2015).

The motor function involvement post-stroke can be partial, or total based on the anatomical area involved in the cerebral cortex. However, greater than 50% of stroke individuals have motor impairments in the upper limb that seriously affects their functional capacity among stroke subjects. Subjects with stroke must undergo upper extremity rehabilitation to enhance their motor function to the subsequent levels (Zeng et al., 2018). Moreover, in the developed countries, there is a dedicated proportion of total healthcare costs ranging from 2% to 4% only for stroke, which is very high and can be decreased if there are good rehabilitation strategies (Li et al., 2019).

The multi-disciplinary approach is the current trend in rehabilitating post-stroke subjects, and one of the important vocations is physical therapy in this multi-disciplinary care. The primary focus of physical therapists is to rehabilitate the subjects to improve their ADL; they usually start their sessions after stabilizing the acute signs and symptoms after stroke and continue their rehabilitation up to chronic stages (Veerbeek et al., 2014). Rehabilitation of the stroke subject does not restrict only to the motor recovery of the upper extremity. Other aspects like muscle strengthening, muscle elongations, balance improvements, and gait rehabilitation are crucial for the overall development of functional capabilities in stroke subjects (Chinnavan et al., 2020; Gurbuz et al., 2016).

There are various rehabilitation strategies used after stroke in enhancing upper extremity capacity. They were constraint-induced movement therapy (CIMT), functional electrical stimulation (FES), mirror therapy (MT), neurodevelopmental treatment, proprioceptive neuromuscular facilitation

(PNF), task-oriented approach, and robotic rehabilitation (Shaker et al., 2020; Beltrán-Rodrguez et al., 2022). Among them, MT is an alternative therapy based on the interaction of visual proprioception inputs. It is a form of mental imaginary technique widely popularized in recent decades (Jose, 2014).

Mirror Therapy was initially designed for decreasing phantom limb pain post amputations by Ramachandran et al. Their research described the methodology of MT. The subject will be seated with hands in front on a table where the unaffected hand will be beside the visible side of the mirror, and the affected hand will be behind the mirror. The mirror is positioned vertically and more towards the affected side so that the actions of the sound hand can be seen in the mirror, creating the illusion in the patient's brain that the unsound hand is moving. (Zeng et al., 2018).

Altschuler et al. are the first authors who used this MT to rehabilitate upper extremities among stroke subjects. The subjects who participated in the study provided positive feedback about this MT. There were some negative remarks in this study, like, as the sample size was only nine and the outcome measures used in the study were subjective; hence the generalizability of the study was not rational at that time. However, after Altschuler et al.'s investigation, many further studies with strong methodological quality had proven the effects of MT in enhancing the upper extremity capacity among stroke subjects (Zeng et al., 2018). The advantage of MT over other conventional physical therapies (CPT) is it does not require any degree of voluntary movement in the affected hand to start the treatment. Hence it can be used in completely paralyzed stroke hands also. Moreover, the MT depends on visual stimulation of cortical mirror neurons in the brain than using any other somatosensory stimulation (Gandhi et al., 2020).

While performing MT, the subjects will be moving the non-affected hand into various functional movements. The subject will be observing these movements in the mirror and perceives them as movements in the affected hand. Because of this visual illusion of the affected hand movements, the cortical mirror neurons will be activated and causes neuroplasticity in the affected brain which will be further helpful in the functional recovery of the affected hand (Dohle et al., 2009; Park et al., 2015).

The therapy commonly uses a mirror box where the subjects' affected extremity will be kept. The subject will visualize the mirror's normal extremity movement while practicing the affected extremity's movements inside the mirror box. This kind of mirror image will facilitate the mirror neurons in the affected side of the brain and stimulate the motor neurons connecting to the affected side extremity muscles, thus improving motor function (Jose, 2014).

Combining this physical and mental practice has claimed to improve motor function up to 80-95 percent among many stroke subjects (Jose, 2014). The concept of MT was influential in the stroke population and showed its positive effect in various other conditions like cerebral palsy, phantom limb pain, complex regional pain syndromes, and fracture healing (Habibi-Koolaee et al., 2018). MT was initially designed to rehabilitate the upper extremity, but the concept was later used for the lower extremity recovery. However, the many previous literatures on MT had shown positive effects mainly in upper extremity rehabilitation, especially on improving motor function (Kim & Lee, 2017; Lim et al., 2016; Park et al., 2015; Shaker et al., 2020).

1.1 Motivation of the study:

One of the most challenging issues in stroke survivors is upper limb rehabilitation. Abundant rehabilitation methods for stroke subjects have improved upper limb motor functional skills. Approaches include mirror therapy, CIMT, impairment-oriented training of the arm (Bobath therapy), PNF, FES, neurodevelopmental treatment, motor re-learning program (MRP), and robotic rehabilitation. However, the mirror therapy technique is simple, affordable, and easy to administer. Moreover, there is limited research available regarding MT for stroke rehabilitation in the Kingdom of Saudi Arabia. Hence, patients are the primary concern of every clinical approach; the current study intends to find out the effectiveness of MT in combination with CPT on improving upper extremity motor function among chronic hemiplegic subjects in the Kingdom of Saudi Arabia (Shaker et al., 2020; Beltrán-Rodrguez et al., 2022).

1.2 Purpose:

The purpose of the study was to determine the effect of mirror therapy versus conventional physical therapy treatment in improving upper extremity impairments and motor function among chronic hemiplegic subjects.

1.3 Research Objectives:

1. To discover the effectiveness of conventional physical therapy treatment on improving upper limb motor function among chronic hemiplegic subjects.

2. To find out the effect of mirror therapy along with conventional physical therapy treatment on improving upper limb motor function among chronic hemiplegic subjects.
3. To find out the effectiveness of mirror therapy combined with conventional physical therapy treatment versus conventional physical therapy treatment alone on improving upper extremity motor function among chronic hemiplegic subjects.

1.4 Hypotheses:

- **Null Hypothesis:**

It assumed that there is no effect of Mirror Therapy on improving upper limb motor function among chronic hemiplegic subjects.

- **Alternative Hypothesis:**

It assumed that the Mirror Therapy has an effect on improving upper limb motor function among chronic hemiplegic subjects.

CHAPTER II

2.0 Review of the Literature

2.1 Stroke

Cerebrovascular accident (CVA) is a neurological condition occurred by vascular obstruction. Cerebral clots impede blood circulation, clutter up the vascular circulation, and cause capillaries to rupture, resulting in hemorrhage. Neurons die abruptly owing to a shortage of oxygen in cerebrovascular vascular accident (Kuriakose & Xiao, 2020).

According to the WHO, a CVA is the sudden development of a neurogenic disorder owing to localized or generalized vascular causes. The symptoms persist for more than twenty-four hours following the start (Alqahtani et al., 2020). Being a significant and widespread cause of impairment on a global scale, CVA is considered as one of the most critical global health challenges (Sala et al., 2022).

2.1.1 Types and Causes:

The two primary forms of CVAs are ischemic and hemorrhagic. Ischemic CVA is a neurodegenerative disorder characterized by a localized cerebral, spinal, or retinal infarction lasting more than 24 hours. A transient ischemic attack (TIA) is defined in the literature as a "temporary occurrence of neurological dysfunction caused by the localized brain, spinal cord, or retinal ischemia without acute infarction." TIAs are typically characterized as mini-cerebrovascular accidents with flashing symptoms (i.e., lasting from minutes to hours but less than 24 hours) (Parmer, 2018). In TIA, blood flow to a portion of the brain is briefly obstructed. It serves as a warning indication before the occurrence, allowing you to alter your lifestyle and start taking drugs to minimize your risk of a CVA (Kuriakose & Xiao, 2020).

Two forms of hemorrhagic CVAs exist. Subarachnoid hemorrhage accounts for around five percent of all CVAs, while intracerebral hemorrhage accounts for approximately ten percent of all CVAs. Subarachnoid hemorrhage is the result of hemorrhaging from a cerebral blood vessel, an aneurysm, or vascular dilation into the subarachnoid space, the region encompassing the central nervous system where the vascular system is located between the arachnoid and pia mater. (Parmer, 2018). Subarachnoid hemorrhage is caused by a cerebral blood vessel, aneurysm, or vascular distortion in the subarachnoid space, which is the region surrounding the brain in which blood vessels are situated adjacent to the arachnoid and pia mammy. (Parmer, 2018).

Patients with subarachnoid hemorrhage typically have a sudden onset of severe headache, vomiting, and non-focal neurological impairments such as memory loss and neck stiffness (Parmer, 2018). A CVA induced by intracerebral bleeding is a sudden, non-traumatic development inside the brain parenchyma or ventricular system (Parmer, 2018). Intracerebral hemorrhage occurs on its own or when a compromised blood vessel in the brain ruptures, allowing blood to collect, elevating intracranial pressure, and damaging brain cells in the vicinity of the bleed. A larger hematoma is associated with reduced functional recovery and an increased death rate (Parmer, 2018).

2.1.2 Risk Factors:

After age 55, the risk of a CVA doubles for both men and women. When a person has a medical condition such as coronary artery disease, hypertension, or hyperlipidemia, the risk of a cerebrovascular accident increases. Individuals with a transient ischemic attack account for roughly 60% of all CVAs. Some risk factors for a CVA are modifiable, while others are not (Kuriakose & Xiao, 2020).

Non-changeable risk factors: Age, gender, race, ethnicity, and hereditary traits are factors that cannot be altered. A recent study found that adults between the ages of 20 and 54 are at a greater risk of a CVA, likely due to preexisting secondary causes (Kuriakose & Xiao, 2020). Whereas gender is considered, women face an equal or lower risk of a CVA than men, regardless of age (Kuriakose & Xiao, 2020). A U.S.A study reveals that Hispanic and black populations have a higher risk of CVAs than white populations and that the number of hemorrhagic CVAs in black individuals is significantly higher than in white individuals of the same age. (Kuriakose & Xiao, 2020)**.** Genetics is considered both non-modifiable and immutable CVA causative factors. CVA risk is proportional to an individual's age, gender, and race, although many heritable pathways might raise this risk (Kuriakose & Xiao, 2020).

Important are modifiable risk factors, as prompt and suitable medical intervention can lessen the occurrence of CVA in vulnerable patients. The most important changeable risk factors for cerebrovascular accidents are hypertension, diabetes, inactivity, alcohol and substance addiction, cholesterol, dietary management, and heredity. (Kuriakose & Xiao, 2020).

Hypertension: Hypertension is one of the primary risk factors for CVA. 54% of the CVA-affected cohort exhibited both a minimum blood pressure of

160/90 mmHg and a history of hypertension. CVA risk is prevalent in both hypertensive and normotensive individuals. (Kuriakose & Xiao, 2020).

Diabetes: It raises the incidence of ischemic CVAs and has a roughly 20-fold increase in mortality. Furthermore, diabetic individuals had a poorer prognosis after a CVA than non-diabetic patients, with a greater frequency of severe impairment and a shorter recovery duration (Kuriakose & Xiao, 2020).

Atrial fibrillation: Depending on age, atrial fibrillation is a substantial risk factor for CVA, increasing the risk by two to five times. It contributes 15 percent of all CVAs and causes more disability and death than CVAs unrelated to atrial fibrillation (Kuriakose & Xiao, 2020).

Hyperlipidemia: This is a significant factor for coronary heart disease, although its association with CVAs is complex. Total cholesterol is connected with the risk of having a CVA, but high-density lipoprotein reduces the risk of having a CVA. Hence, assessing the lipid profile permits the estimation of the risk of a CVA. According to one study, low levels of high-density lipoprotein, high levels of total triglyceride, and hypertension were associated with a twofold increase in the overall population's risk of CVA-related death (Kuriakose & Xiao, 2020).

Alcohol and substance abuse: the association between CVA and alcohol consumption follows a curved path. The risk of stroke is proportional to the daily quantity of alcohol ingested. Moderate to moderate alcohol intake reduces the risk of a CVA, but excessive alcohol consumption raises the risk. In contrast, modest alcohol intake increases the risk of having a hemorrhagic CVA (Kuriakose & Xiao, 2020).

Smoking: Cigarette consumption is closely related to a higher incidence of CVA. Smoking is responsible for 15% of CVA-related fatalities. The risk of a CVA for a typical smoker is double that of a nonsmoker. (Kuriakose & Xiao, 2020)**.**

Physical Activity: Inactivity and inadequate nutrition are associated with an increased risk of cerebrovascular accident (CVA). Inactivity increases the likelihood of suffering a CVA. Inadequate physical exercise is also linked to other health problems such as overweight, diabetes, and elevated blood pressure, all of which are linked to severe CVAs. A poor diet increases CVA risk by causing hypertension, hyperlipidemia, obesity, and diabetes (Kuriakose & Xiao, 2020).

2.1.3 Complications:

A Cerebrovascular accident causes a temporary or everlasting loss of function that affects physical, cognitive, and psychological aspects, causing restrictions on independent day-to-day life. Approximately 75% of patients with CVAs have disabilities that limit their ability to live independently daily. However, because of helplessness and depression, interpersonal relationships and quality of life may suffer if dependence on day-to-day life continues (Moon et al., 2022).

The most prevalent neuropsychiatric consequences following a cerebrovascular stroke are depressed symptoms. Post-CVA depression develops in 25–75 percent of cases (Whitehead & Baalbergen, 2019).

In each case, the severity of neurological problems is determined by the area and severity of the brain damage, the amount of additional blood flow, and the efficacy of early acute care. As brain edema subsides, impaired symptoms may resolve spontaneously, typically within three weeks. Neurological impairments that persist beyond three weeks may result in a permanent disability. (Chinnavan et al., 2020).

Secondary complications can negatively impact a case's rehabilitation. These include:

Spasticity: Spasticity can severely limit the mobility of a patient. Numerous rehabilitative therapies, including passive stretching, splinting, and posture and movement therapy, may alleviate spasticity. Beneficial treatments include oral medications such as baclofen and clonazepam, as well as parenteral therapies such as botulinum toxin injected into the problematic muscles. Ineffective management of spasticity reduces functional capacity and causes excruciating contractures, making hygiene difficult, especially in the contracted hand. (Whitehead & Baalbergen, 2019).

Pain: Shoulder discomfort is a typical symptom of CVAs. Frequently, physical therapists can assist with strapping, massage, or passive motions. Pharmacological treatments may be required. A typical outcome of a cerebrovascular injury is also central or neuropathic pain. It is beneficial to utilize gabapentinoids, such as pregabalin and gabapentin. However, these drugs may have adverse psychological effects (Whitehead & Baalbergen, 2019).

Pressure sores: Patients with CVAs are more likely to develop pressure ulcers, largely due to decreased mobility. Practical preventive measures include frequent bed repositioning, a healthy diet, and patient and family caregiver education on pressure care. If a pressure sore develops, prompt evaluation and treatment by a neurologist and pressure ulcer-trained nurses are required (Whitehead & Baalbergen, 2019).

Deep vein thrombosis (DVT) and pulmonary embolism: Reduced mobility in CVA patients increases their risk for DVT and pulmonary embolism. Compression stockings and low-molecular-weight heparin are used as preventative measures. Physicians and nurses must be aware of any clinical signs of DVT or pulmonary embolism in order to ensure prompt diagnosis and treatment. (Whitehead & Baalbergen, 2019).

Urinary and fecal incontinence: In the acute therapy of a CVA patient, the use of an indwelling catheter assists in fluid management, avoids urine retention, and prevents epidermal degeneration. However, sustained use raises the probability of urinary tract infections. These frequently necessitate antibiotic treatment, as multiresistant organisms continue to proliferate. Infections affect people who are unable to participate in the healing process. Within the initial two weeks following a CVA, fecal incontinence commonly recovers. Nonetheless, fecal impaction courses are prevalent, and preventative treatment is crucial (Whitehead & Baalbergen, 2019).

Aspiration pneumonia: Aspiration is a risk for individuals with dysphagia. The interventions of a speech-language pathologist help to mitigate this risk. In addition, a physician should have a low threshold for the early treatment of any signs and symptoms of aspiration prior to the development of aspiration pneumonia. In cases of uncertainty, patients should be fed via nasogastric tube until a speech-language pathologist clears them for secure oral input. (Whitehead & Baalbergen, 2019).

The crippling effects of a CVA depend on the affected parts of the cortex. Motor impairment is the most common consequence of a CVA involving 80% of patients; it is characterized by variable degrees of facial, arm, and leg weakness in one half of the body and is known as hemiplegia (Whitehead & Baalbergen, 2019).

Motor deficiency is the leading cause of physical disability after a CVA, and therapy focuses mostly on this area. In more severe cases, bilaterally innervated muscle activities, such as trunk control, may be compromised (Beltrán-Rodrguez et al., 2022).

CVA is more likely to be caused by specific lesions than diffuse lesions; consequently, these presentations are well-suited for clinical-anatomic localization. Hemiplegia is most frequently caused by brain lesions. It is possible that lesions in cortical or subcortical regions are the cause of the paralysis. The most probable cause of cortical hemiplegia is a CVA affecting the entire internal carotid artery territory. (Chinnavan et al., 2020).

2.1.4 Epidemiology (Local & Global):

Cerebrovascular accidents are the third greatest cause of life lost globally; age-standardized years of life lost grew by 12.9% between 1990 and 2007 and 12.1% between 2007 and 2017. Between 2007 and 2017, the global death toll from CVAs climbed from 5.29 million to 6.17 million. From 1990 to 2013, the development of multi-morbidity and the impacts of longevity indicated by the global disease burden increased disability-adjusted life years attributable to CVAs from 3.54% to 9.66%, and there were roughly 25.7 million CVA survivors worldwide in 2013. In the past forty years, high-income nations have seen a 42% decline in CVAs, but low- and middle-income countries have seen a 100% increase. One-third of the world's 62 million CVA survivors are severely disabled. More than 80% of disability-adjusted life years are attributable to low- and middle-income countries (Gandhi et al., 2020).

Recent estimates indicate that over 650 million individuals worldwide are 60 or older and are predicted to reach 2 billion by 2050 (Sala et al., 2022). In Middle Eastern countries, CVAs ranged from 22.7 to 250 per 100,000 people yearly (Alhazzani et al., 2018).

In contrast, the prevalence of CVAs in the Kingdom of Saudi Arabia is 43.8% per 100,000 residents. Saudi Arabia is a country that has undergone remarkable development throughout the last two decades and has changed swiftly as a developed nation. As a result, considerable lifestyle changes and environmental factors have increased this nation's risk and incidence of CVAs (Bakraa et al., 2021). However, studies in various parts of Saudi Arabia have cited disparate and contradictory CVA incidence rates, including 15.1/100,000 in Jizan, 29.8/100,000 in the Eastern Province, and 43.8/100,000 in Riyadh (Alhazzani et al., 2018; Shaker et al., 2020).

According to the study of the global disease burden, even though the prevalence of CVAs has reduced, the age, gender, and geographic location of individuals affected have increased, resulting in a greater socioeconomic burden of CVAs (Kuriakose & Xiao, 2020). The incidence of cerebrovascular accidents doubles after age 55. Between 1990 and 2016, CVAs among individuals aged 20 to 54 years grew from 12.9% to 18.6% of all occurrences globally. In contrast, age-standardized attributable mortality rates decreased by 36.2% during the same time period. Cerebrovascular accidents are most common in China, with an estimated 331-378 incidences per 100,000 person-years. The rate in Eastern Europe is the second highest (181-218 per 100,000 life years), while the rate in Latin America is the lowest (85-100 per 100,000 life years) (Kuriakose & Xiao, 2020). Men and women experience CVAs at different rates with advancing age. In women, the incidence is higher at earlier ages, whereas in males, it increases only slightly with age. Pre-eclampsia, contraceptive use, hormone therapy, and migraine with aura are pregnancy-related factors that increase the risk of CVAs in women. Men have a higher risk of brain infarction and intracerebral hemorrhage (ICH), whereas women have a higher risk of a severe cardio embolic CVA. Additionally, the CVA mortality rate is greater among women. The primary causes of CVAs in men include tobacco use, excessive alcohol use, myocardial infarction, and vascular diseases (Kuriakose & Xiao, 2020).

Geographic and racial variation: as previously stated, the prevalence of CVAs varies greatly throughout the world. A global population-based investigation of the prevalence of CVAs and related hazards evaluated demographics, behavior, physical characteristics, medical history, and laboratory data, and found that exposure to air pollution and particulate matter contributed to CVA mortality. (Kuriakose & Xiao, 2020).

Variation in socioeconomic level: There is a substantial negative link between CVAs and socioeconomic level due to poor hospital facilities and post-CVA treatment in low-income communities (Kuriakose & Xiao, 2020).

According to a study, the incidence rate is as high as 851.81 per 100,000 adults older than 70. Awareness of any health condition's prevalence, incidence, and risk factors may reduce the incidence rate. Researchers suggest that a lack of public awareness about the risk factors for CVAs may cause the high incidence rates of these accidents among the Saudi population (Bakraa et al., 2021).

Still prevalent among CVAs survivors is motor dysfunction of the upper or lower limbs. Whereas only 30–60% regain some dexterity after six months, arm paralysis frequently creates difficulty with everyday tasks. (Arfianti et al., 2022). According to statistics, more than 70% of CVA survivors have some degree of upper-limb and hand mobility impairment (Pan et al., 2021)**.** Post-CVAs motor function involvement may be partial or complete, depending on the anatomical region of the cerebral cortex affected (Zeng et al., 2018). The recovery of a patient's motor function is predicated primarily on rehabilitation training. Nevertheless, due to the diversity of individuals, it is essential to tailor rehabilitation programs to varying degrees of motor impairment (Pan et al., 2021).

Various post- CVA therapies that purposefully or unintentionally boost the plasticity of the surviving neural circuit have been created to enhance recovery (Su & Xu, 2020). Brain plasticity is the brain's inherent capacity to reconfigure its function and structure in response to external stimuli and traumas. After a CVA, the plasticity process is launched to adjust for both the lesion and its far-reaching consequences. Perilesional and distant regions and the contralateral hemisphere exhibited altered brain activity and connections in function and structure, which were believed to represent the processes allowing spontaneous recovery. In general, greater brain activity and connections in the ipsilesional hemisphere have been cited as indications of functional recovery (Su & Xu, 2020).

Regardless of the substantial studies conducted on CVAs over the past twenty years, no simple treatment or prevention methods are currently identified for all of their clinical causes. CVA prevention entails altering risk factors within a population or an individual, whereas CVA treatment involves dealing with its pathophysiology. Modifications to the factors that cause primary and secondary CVAs may result in the creation of novel therapies (Kuriakose & Xiao, 2020).

For neuroplasticity to result in recovery, rehabilitation treatments must be repetitive, rigorous, and task-specific (Gandhi et al., 2020). System recovery is possible if the damage to a working system is only partial. Alternatively, if the damage is extensive, the only option for functional recovery of the wounded part is to replace it with a functionally similar system. Each of the mechanisms involved in the functional recovery process following a brain injury will depend on the extent of the damage (Beltrán-Rodrguez et al., 2022).

Combining intrinsic or spontaneous neurological healing with functional recovery, motor rehabilitation is multifaceted. The severity of the initial deficiency is negatively related to the likelihood of intrinsic neurological recovery, which is the recovery of normal movement patterns. It typically occurs within the first 1–3 months following the occurrence. Functional recovery is the restoration of fundamental tasks or daily activities through acquired compensatory movements, which depend on learning capacity, motivation, family support, and the intensity and quality of rehabilitative care (Beltrán-Rodrguez et al., 2022).

After a brain injury, three structures recover motor activity and function: undamaged perilesional portions of the involved primary motor cortex, same-side and opposite-side auxiliary motor systems, and areas responsible for executive control and the contralateral motor system (Beltrán-Rodrguez et al., 2022).

2.1.5 Rehabilitation:

A Cerebrovascular accident leads to permanent or temporary disability. Typical daily activities like walking and using the restroom are frequently impaired, as are sensorimotor and visual impairments (Kuriakose & Xiao, 2020).

Rehabilitation following a CVA is a goal-oriented, patient-centered procedure that aims to maximize the functional autonomy of subjects with various CVA-related disorders. Post- CVA rehabilitation aims to assist the CVA survivor in returning to their premorbid functioning within their family, community, and, if possible, employment environments. Rehabilitative services can be administered in either an inpatient or outpatient setting (Whitehead & Baalbergen, 2019).

Priority is given to the recovery of patients since it enables them to undertake ADL independently, minimizing the burden on caretakers and medical workers, and allowing them to resume social involvement, thus enhancing their quality of life (Sala et al., 2022).

Rehabilitation after a CVA may involve physical, occupational, speech, and cognitive therapy. It aims to assist patients in regaining problem-solving skills, obtaining access to social and psychological support, enhancing mobility, and attaining independence. Rehabilitation may also involve neurobiological challenges to mitigate cognitive impairment, induce synaptic plasticity, and promote long-term potentiation. Visual computer-assisted gaming activities have improved visuomotor neural plasticity in patients with a history of CVAs (Kuriakose & Xiao, 2020).

Despite the necessity of restoring upper-limb function in CVA survivors, depending on the degree of the condition, recovering complete motor function may not always be achievable. In a CVA population with some residual muscular activation, it has been discovered that exercise- or physical therapy-dependent brain plasticity can recover sensory-motor function (Sala et al., 2022).

2.1.5.1 Physical Therapy Techniques

Standard CVA rehabilitation for hemiparesis after a CVA focuses on motor and sensory re-education by using the ask-specific and functional exercises of the affected extremity and an electroencephalogram (EEG) evaluation that is used to examine the progress of CVA rehabilitation (Arfianti et al., 2022).

The importance of physical therapists in managing post-CVA care has grown in recent years. physical therapists have launched clinical trials of CVA rehabilitation and recovery procedures. One continuing study includes a method of addressing disability that enhances mobility using electromechanical device therapy, treadmill exercise, and circuit training (Kuriakose & Xiao, 2020).

Assistive technologies like prosthetic limbs and devices are realistic options for replacing lost bodily functions. These innovations can move a person's unsound arm or electronically trigger muscles to cause limb contractions. Long ago, it was established that adaptive plasticity plays a significant role in motor recovery after a CVA. Experimental evidence shows that intervention with many therapy techniques benefits rapid motor recovery, and cerebral plasticity plays an unquestionably important role in rehabilitating neural networks (Sala et al., 2022).

Due to the brain plasticity phenomenon, the patient will acquire new motor abilities through experience and training. Various rehabilitation interventions can affect this brain-remodeling substrate. Each physical therapist administers these therapies through his or her knowledge and experience (Beltrán-Rodrguez et al., 2022).

Compensation techniques: They strive to retrain residual capacities, particularly in the unaffected hemisphere, to increase function. They are prescribed for critically unwell individuals with a poor prognosis or during the stabilization phase in the unaffected hemisphere. They are prescribed for for critically unwell individuals with a poor prognosis or during the stabilization phase (Beltrán-Rodrguez et al., 2022).

Neuromotor approaches or enabling techniques aim to enhance the affected side's motion quality. There are various approaches:

Bobath method: Inhibitory techniques (which diminish spasticity, synergy, and aberrant patterns) and facilitation techniques (which favor the formation of normal posture patterns) are utilized, and the plegic side is encouraged to participate in treatment activities (Shaker et al., 2020; Beltrán-Rodrguez et al., 2022).

The Brunstrom approach: It is based on the stimulation of synergies for the patient's involuntary production of analytical motions (Beltrán-Rodrguez et al., 2022).

PNF: It is alleviating muscle weakness. It uses superficial (touch) or deep (joint position, stretching) distal signals to improve muscular strength and coordination. It depends on movement patterns wherein stronger agonists reinforce weak muscles (Beltrán-Rodrguez et al., 2022).

Techniques for MRP or task-oriented rehabilitation: It sought to improve the patient's performance of specific tasks that had practical significance in his or her life. Learning involves training that is repetitive and rigorous, progressively demanding, and accompanied by feedback on performance and motivational techniques (Zeng et al., 2018; Beltrán-Rodrguez et al., 2022).

The application of technology to task-oriented rehabilitation programs: For instance, the application of functional electrical stimulation to the lower extremities as an alternative to a traditional orthosis or biofeedback for the patient Technology can aid in the automation of the training activity (Beltrán-Rodrguez et al., 2022).

Physical therapy for the upper extremity:

Contrary to the lower limb, only a minority of individuals achieve good upper limb function. The goal of the rehabilitation treatment will be to restore as much function as possible to the damaged upper limb.

In addition to muscle strengthening, assisted passive and active kinesitherapy of the affected upper extremity is used (Zeng et al., 2018; Beltrán-Rodrguez et al., 2022). The functional rehabilitation of the afflicted side is enhanced by a mental rehearsal of motions and activities (Beltrán-Rodrguez et al., 2022). The exact therapeutic methods employed are:

CIMT: Utilizing the injured limb while immobilizing the good limb (Beltrán-Rodrguez et al., 2022). CIMT with healthy side suppression was better than the traditional treatment for improving the functional mobility of the unsound upper extremity, enhancing grip and speed of movement in daily activities (Shaker et al., 2020; Zeng et al., 2018; Beltrán-Rodrguez et al., 2022).

Mirror Therapy: It benefits motor rehabilitation and pain reduction of the afflicted limb. Using a mirror for visual input, both extremities are mobilized while viewing the healthy side reflected (Shaker et al., 2020; Zeng et al., 2018; Beltrán-Rodrguez et al., 2022).

Virtual reality (VR): A simulation of the real world is created, and human-computer feedback is generated as the patient does the planned activities. Presently, it is superior to traditional occupational therapy in lowering the impairment of the injured limb while enhancing the latter's effects (Beltrán-Rodrguez et al., 2022).

Functional electrical stimulation and concurrent task-specific exercise: Motor recovery is stimulated by the synchronicity between the increase in sensory inputs to the central nervous system (CNS) and muscle contraction (Shaker et al., 2020; Beltrán-Rodrguez et al., 2022).

Robot-assisted upper extremity therapy: When the patient lacks sufficient strength, it is administered. As an adjunct therapy to physical theray, it increases treatment intensity by enhancing motor function in the shoulder, elbow, and wrist but has not been demonstrated to improve ADL performance (Shaker et al., 2020; Zeng et al., 2018; Beltrán-Rodrguez et al., 2022).

Transcranial stimulation promotes neuroplasticity by noninvasively and safely interfering with the patient's learning and motor function (Beltrán-Rodrguez et al., 2022).

Most people think MT, action observation treatment, and CIMT will work better than traditional rehabilitation methods (Su & Xu, 2020).

<u>Physical therapy for the lower extremities</u>:

It should begin within the first few days. Orthostasis and some motor coordination should be mastered as soon as possible. The primary purpose is to enhance mobility and regain motor control of standing and walking to increase independence and decrease energy costs. Typically, individuals who can safely perform standing and transfers during the subacute phase regain ambulation with the support of mechanical devices such as orthoses, canes, or a walker in some scenarios (Beltrán-Rodrguez et al., 2022).

Typically, the following phases are observed: standing commencement, balance retraining, parallel standing, and walking. The following methods are employed: Passive, assisted, and active kinesiotherapy, in addition to muscular strength training, is crucial for dynamic stability during the support phase of walking (Beltrán-Rodrguez et al., 2022).

Re-education of balance: Affected in CVA patients due to reduced motor control in the trunk and lower extremities, the sensitivity of the corresponding hemiside, and a perceptual abnormality, it is difficult to maintain the correct balance. It must be treated because it can lower the danger of falling (Beltrán-Rodrguez et al., 2022).

Physical reconditioning: A tailored aerobic exercise program, including major muscle groups, is required to counteract tiredness and enhance cardiovascular resistance. Throughout the performance of the same, heart rate and blood pressure should be monitored (Beltrán-Rodrguez et al., 2022).

Training treadmill gait with or without body weight support improves gait characteristics by enhancing mono-pedal support on the affected side, step alternation, and spinal erector activation. Functional electrical stimulation of the injured lower extremity, mental imagery, and virtual reality also improve gait in stroke subjects (Beltrán-Rodrguez et al., 2022).

The positional sensation is a crucial aspect of postural control and a component of proprioception. In order to improve balance, practicing postural proprioception could be a feasible therapeutic option for CVAs survivors with decreased trunk position sense, which may result in trunk instability. Core stability is the capacity to stabilize the spine through local muscle action. The "core muscles" are a collection of muscles that stabilize the lumbar-pelvic-hip complex. Therefore, "core stability training" involves the contraction of the abdominal muscles and pelvic movement to activate the deep trunk muscles. Strong evidence suggests that training in trunk control and core stability can enhance seated and standing balance, mobility, trunk control, and neuromuscular integration, thereby enhancing ADLs. (De Luca et al., 2020).

2.2 Mirror Therapy

Mirror Therapy is a form of rehabilitation in which the reflection (visual input) of a non-affected limb in motion creates the illusion that the affected limb is moving. Positioning a mirror between the legs or limbs allows for MT. After a CVA, MT effects on motor deficits, sentiments, visuospatial neglect, and pain have been investigated (Gandhi et al., 2020). This strategy of treating phantom limb pain was developed by Ramachandran and Roger

Ramachandran. This article paved the way for future research on MT for individuals suffering from peripheral nerve damage, pain syndrome, or CVA (Arfianti et al., 2022).

Mirror Therapy focuses on moving and viewing one's sound side in front of a mirror. Due to this, vision of the afflicted hand's typical movement in the mirror and motor imagery of the paretic hand's movement are formed. In addition to preventing or reducing learned nonuse phenomena, feedback from the affected side increases brain plasticity (Arfianti et al., 2022).

Enhanced structural connections in both hemispheres were associated with improved performance, and functional reactivation on the injured side assisted recovery (Su & Xu, 2020). The mirror neuron system, which refers to neurons engaged in the execution of observed behaviors, was improved by MT after a CVA. Aside from physical therapy, technological advancements have enhanced the recovery methods for CVA (Su & Xu, 2020).

Mirror Therapy can be used on completely paralyzed or severely paralyzed CVA survivors, unlike other therapies that require some degree of voluntary movement, because it employs visual rather than somatosensory stimuli to evoke the desired response in the affected limb (Gandhi et al., 2020). MT has the potential to considerably enhance upper and lower extremity motor capabilities and other ADL-supporting functions. MT functions by stimulating relevant brain regions, including the frontal lobe (Zhang et al., 2021).

As indicated by a previous research Arfianti et al. Mirror Therapy can help with motor behavior rehabilitation in the afflicted lower and upper extremities. Combining MT with twice-weekly hand paresis rehabilitation enhances upper-limb motor recovery and independence in self-care following a CVA. On 18 patients with subacute CVA, a randomized controlled trial was conducted to determine how the inclusion of MT in conventional therapy for hand paresis has an effect on the motor recovery of upper extremity and self-care independence after a CVA. The experimental group received 20 minutes of MT in addition to conventional rehabilitation, whereas the control group received the standard program (Arfianti et al., 2022).

In a second randomized clinical trial, the effectiveness of MT on motor recovery in CVA patients was evaluated. There were three groups of 93 patients: MT, non-reflective surface, and control. The patient profile questionnaire, the Mini-Mental State Examination, and the Brunnstrom Recovery Stages (BRS) were all used in this investigation. The intervention groups completed 20 sessions of MT following the standard physical therapy program. In the 20th session, a pairwise comparison of their motor recovery phases indicated a significant difference between the non-reflective surface and MT groups (P = 0.043). Also, there was a statistically significant difference in motor recovery phases between the MT and control groups (P = 0.0333). In addition, there was no difference between the nonreflective surface group and the control group. The data suggest that MT can enhance the motor recovery of patients with CVAs (Ashrafi et al., 2022).

In addition, a controlled experiment with randomization was conducted. A comparison of the effects of task-based MT and repetitive facilitation exercise on the upper-limb function of CVA patients. Non-probabilistic purposive sampling was utilized with n = 50 subacute and chronic post-CVA patients between the ages of 40 and 50. Included were individuals with a Modified Ashworth Scale (MAS) of 3 and a first-ever CVA. Using the sealed envelope method, participants were randomly assigned to mirror treatment (n = 25) and repetitive facilitation exercise (n = 25) groups. Upper extremity functional index (UEFI) was utilized to assess the functional impairment of individuals with upper limb dysfunction. A post-CVA patient was given the Wolf Motor Function Test (WMFT) for upper extremity performance and functional capabilities and the BRS for upper extremity motor function. All individuals were examined at their initial visit, three weeks later, and again after six weeks of 30-minute, three-times-per-week interventional sessions.

After six weeks of MT and repetitive facilitation exercise, the upper limb motor abilities of patients with acute CVA improved. Nonetheless, MT has shown significant effects on the functional index of the upper extremities (Karamat et al., 2022).

A recent study aimed to develop and carry out a physical therapy program and technique for its application, including MT, to improve upper-extremity motor function in ischemic brain illness survivors and evaluate its efficacy. Ischemic CVA patients were separated into control and experimental groups. Ten patients comprised each cohort. All patients received physical therapy under identical circumstances. In the experimental group, the physical therapy approach intended to enhance and restore upper limb motor functions, alleviate discomfort, regain fine motor abilities, and promote the correct and ergonomic daily activity performance. Active-assisted, active breathing exercises; proprioceptive neuromuscular facilitation; exercises on devices; mechanotherapy; sensory exercises; exercises with a Swiss ball; and mobilization of the upper limb's peripheral joints were utilized in both study groups. Before commencing the set of exercises, 10 minutes of MT were administered to the experimental group, with the duration progressively increasing to 30 minutes. In the control group, only the exercise program was carried out. Diagnostic imaging (computerized tomography (CT), magnetic resonance imaging (MRI), and electromyography (EMG)), the Barthel Index, Brunnstrom test, Ashworth test, Mischel's test, Fuglmeyer's test, Abilhand test, and the visual analog scale (VAS) based on statistically significant results obtained, it is possible to conclude that the approval of MT for the upper extremity in the late stages of recovery for ischemic CVA survivors will encourage arm's functional recovery and, in particular, lessen the loss of fine motor skills. (Mindova & Karaganova, 2022).

Recent research Zhang et al. examined the effects of MT on upper-limb function, ADLs, and depression in post-CVA depressed patients. Between November 2018 and December 2019, sixty post-CVA patients (33 males and 27 females; mean age: 58.4511.13 years; range: 35 to 88 years) were included. The patients were randomly assigned to the control group (n = 30) or the MT group (n = 30). Standard occupational therapy was administered to the control group two times a day. Patients in the mirror group received MT and occupational therapy once a day. All sessions in both groups lasted for 30 minutes each, five times a week for a period of four weeks. Motor function was evaluated using the Fugl-Meyer Assessment of the Upper Extremity (FMA-UE), ADL were evaluated using the Modified Barthel Index, and depression was evaluated using the Hamilton Depression Scale. According to the results, the mirror group demonstrated a more significant improvement than the control group. MT can effectively improve motor function, ADLs, and depression in depressed CVA patients. MT appears to be more effective than conventional occupational therapy from a therapeutic perspective (Zhang et al., 2021).

This review seeks to map available facts and identify the lack of information regarding the benefits of MT on upper-limb recovery and its application for individuals suffering from chronic CVAs. The inclusion criteria were met by twenty publications published between 2010 and 2020 after a scoping review was conducted using a systematic literature search. In accordance with the International Classification of Functioning (ICF), Disability, and Health, the effectiveness of MT for upper-limb rehabilitation and cerebral activity during MT were discussed. The majority of research indicates that MT benefits upper-limb rehabilitation structurally and functionally (Jaafar et al., 2021).

With the type I group, a quantitative, pre-experimental, pretest-posttest investigation was conducted to examine the effect on UE motor recovery. The research included fifteen CVA survivors. For approximately eight weeks, MT was administered three times per week (once in the hospital and twice at home) for 15 to 25 minutes per session. An additional intervention was the implementation of a home program with families trained as supervisors. The instrument used was the FMA-UE. The results of the p = 0.000 hypothesis test indicate that the administration of MT affects the UE motor abilities of post-CVA patients. The results indicated that the MT program had an effect on the UE motor capacity of CVA-recovering patients. There was a statistically significant difference in UE motor capacity between baseline and after MT intervention, with a mean difference of 5.14 and a p-value of 0.000 (0.05). The MT program can be used routinely in hospitals, clinics, and residences for hand rehabilitation (Prasetyaningsih & Kurniawan, 2021).

Another experiment was conducted to determine the effect of MT on the motor functions of the upper extremities of CVA patients. The selection of twenty-two subjects who met the inclusion and exclusion criteria. Randomly, using sealed envelopes, the patients were split into the MT group (Group A) and the control group (Group B). Before and after a 4-week intervention, the action research arm test (ARAT) and the FMA-UE were administered to both groups. Patients in this cohort received CPT in addition to MT. For four weeks, MT sessions lasted 20 minutes per day, five days a week. The control group (eleven subjects): Patients in this group were instructed to perform the same exercises as those in the MT group; however, the mirror was positioned so that the patient could observe the reflection of the afflicted limb (placebo MT). All patients in the MT group received CPT. A statistically significant increase in ARAT scores was observed in both the MT group ($p = 0.00$) and the control group ($p = 0.00$). The FMA-UE score results for the MT group ($p = 0.00$) and the control group ($p = 0.00$) were highly significant. Therefore, interventions in both categories are effective. Using an unpaired t-test, the researchers also contrasted the MT group and the control group to determine whether the MT group experienced greater change than the control group. There were significant differences in ARAT ($p = 0.00$) and FGMR ($p = 0.00$) scores between the MT and control groups after four weeks of intervention. A study demonstrates that MT enhances upper extremity motor capabilities in CVA patients (Nelakurthy et al., 2021).

In a prospective randomized controlled trial (RCT), 25 post-CVA participants were allocated to either the experimental group ($n = 13$) or the control group ($n = 12$) at random. The control group participated in 45-minute CPT sessions for the affected upper limb. In contrast, in addition to MT, the experimental group received three 45-minute CPT treatments each week. Comparing the changes in measurements between baseline and six weeks between the two groups, the outcomes showed that the experimental group experienced a significant improvement. Combining CPT and MT is an effective strategy for recuperating motor behavior in the upper limbs of hemiplegic subjects, according to researchers (Chinnavan et al., 2020).

In a case-control analysis of 30 Egyptians with chronic CVA (19 men and 11 women; age range, 45–65 years), patients were divided into two equal-sized groups (19 men and 11 women; age range, 45–65 years). The study group (15) received physical therapy with MT, while the control group (15) received the same program without MT. There were three treatment sessions per week for eight weeks for both groups. To evaluate improvements in range of motion, motor strength, hand motor functional abilities, and daily activities, the range of motion for wrist extension and forearm supination, hand grasp strength, and hand motor functional skills were examined. Both groups exhibited statistically significant improvements in wrist extension range of motion, forearm supination range of motion, hand grasp strength, and Jebson Hand Function Test time following treatment. Following therapy, the treatment group showed more improvement than the control group. Study concluded that MT positively influences the enhancement of hand motor functional skills (Shaker et al., 2020).

The meta-analysis included ten studies that included 444 subjects who had reduced upper limb capabilities as a result of a CVA. When compared to the control group, combined MT had a substantial influence on upper limb functional recovery. For patients' upper extremities, the results revealed that

MT in association with another kind of rehabilitation is better than rehabilitation therapy alone (Luo et al., 2020).

A recent review of 28 studies attempted to review and provide the current perspectives on MT and its implementation in CVA rehabilitation, as well as dose, feasibility, and acceptability in CVA rehabilitation. The majority of the research focused on post-CVA motor deficits in the upper extremities. The studies were equitably divided between the acute and chronic phases of post-CVA intervention, with therapy durations ranging from 1 to 8 weeks. Results indicate that MT is an effective method for training post-CVA deficits (motor, sensory, and perceptual deficits) in the acute, subacute, and chronic phases (Gandhi et al., 2020).

In addition, a study sought to: (1) compare the impacts of MT and bilateral arm training (BAT) on improving the motor functions of the hemiplegic upper extremity in patients with chronic cerebrovascular accident; and (2) examine, using EEG, whether recruitment of the mirror neurons, as reflected in the form of event-related desynchronization (ERD), mediated recognition of the mirror visual feedback during MT and compare with the effects of thalassemia therapy. The investigation was divided into two sections. Part 1 was a single-blind, randomized, controlled experiment that compared the MT and BAT groups. At baseline, six weeks after therapy, and at the three-month follow-up, data were collected. The second section examines the instantaneous brain response to MT and BAT using cross-sectional EEG measurements for both subject groups. The investigation was divided into two sections. Part 1 was a single-blind, randomized, controlled experiment that compared the MT and BAT groups. At baseline, six weeks after therapy, and at the three-month follow-up, data were collected. The second section examines the instantaneous brain response to MT and BAT using cross-sectional EEG measurements for both subject groups. MT is superior to BAT for improving distal arm capabilities. It is anticipated that mirror visual input will activate the contralateral sensorimotor cortex, rendering the brain more symmetrical during motor recovery after a hemiplegic CVA (Fong et al., 2019).

A randomized controlled trial with assessor concealment was conducted to ascertain the efficacy of mirror treatment in early post-CVA patients undergoing upper-limb rehabilitation. Within four weeks of the CVA, included were 40 patients who had upper-limb impairment as a result of their first ischemic or hemorrhagic CVA. The intervention group was administered MT, while the control group was administered placebo therapy. The patient's hand was reflected in a mirror during MT. During placebo treatment, the reflective surface was substituted with an opaque one. Mirror and sham therapy groups undertake a variety of exercises to enhance their good hand (e.g., reaching and grasping). MT and placebo therapy were added to typical rehabilitation. T FMA-UE is the primary result. The functional independence measure (FIM) scale and the action research arm task are secondary outcomes. On the Fugl–Eyer, action research arm test, and functional independence measure scales, there were no significant differences between the mock and MT groups. When compared to sham therapy, MT provided no incremental benefit to early upper extremity rehabilitation following a CVA. (Antoniotti et al., 2019).

In addition, a study investigated the efficacy of MT on subacute CVA patients' motor recovery and hand-related functioning. Sixty CVA patients were recruited at random within six months of their accident, with each cohort containing 30 patients. Patients in the experimental group received MT treatment for 30 minutes that included movements of wrist and finger flexion and extension each day for four weeks in addition to the CPT rehabilitation program, which was administered six days per week for one hour per day. The MT program was off-limits to participants in the control group. Brunnstrom motor recovery stages and hand-related functionality (self-care items of the FIM instrument). After four weeks of therapy, the experimental group's Brunnstrom stages for hand and upper extremities, as well as the FIM self-care score, improved more than the control group's (by 0.81, 0.86, and 4.1, respectively; all P.05) and at the 6-month follow-up (all P.05) (by 0.18, 0.51, and 2.52, respectively; all P.05) (Mandeep & Khurana, 2019).

The primary objective of a systematic review and network meta-analysis was to investigate the effects of mirror therapy on motor function, ADLs, and pain perception in CVA survivors. The meta-analysis included 37 RCTs (42 analyses, 1685 individuals) that met the inclusion criteria. The increased Fugl–Meyer Assessment (FIM) and decreased Motor Assessment Scale (MAS) scores demonstrated that MT significantly improved motor function. In addition, MT encouraged ADL because the Modified Barthel Index (MBI) and Motor Activity Log (MAL) scores increased. In addition, MT significantly reduced discomfort in CVA patients, as measured by a lower VAS score. Subgroup analyses and meta-regressions identified diverse intervention arms and intervention durations as potential sources of variability. Mirror therapy paired with electrical stimulation for less than four weeks in addition to CPT and MT combined with CPT for fewer than four weeks were shown to be the most potent therapies for improving motor function and ADL, respectively, according to a network meta-analysis. Researchers reported that

MT may enhance motor function and ADLs while reducing discomfort in CVA survivors (Yang et al., 2018)

In a systematic review, MT and other treatments were contrasted in 62 trials involving a total of 1982 individuals. In these studies, there were 57 randomized controlled trials and 5 randomized cross-over trials. The objective was to evaluate the effectiveness of MT in contrast to no treatment, placebo or sham therapy, and other treatments for improving motor behavior and motor disability after a CVA. In addition, the effects of MT on daily activities, discomfort, and visuospatial neglect were evaluated. The authors stated that the data demonstrate the efficacy of MT in improving upper limb motor behavior, motor disability, ADLs, and pain, at least as an adjunct to standard rehabilitation for CVA patients (Thieme et al., 2018).

In addition, Zeng et al. (2018) conducted a meta-analysis to determine whether MT effectively rehabilitated the motor function of the upper extremity in CVA patients with hemiparesis and, if so, to determine the mean treatment effect size of MT on motor function. Through meta-analysis, researchers discovered that in CVA patients, MT may enhance upper limb motor behavior. The studies that were chosen were pilot and randomized controlled trials that contrasted mirror and mirror box treatment with other forms of rehabilitation. The meta-analysis includes 11 studies including 347 individuals (Zeng et al., 2018).

In addition, randomized pilot studies were conducted to confirm the efficacy of MT in restoring motor function in the upper extremities and to recommend a conventional mirror treatment regimen for CVA patients. Nineteen chronic CVA patients were assigned to one of two treatment groups at random: MT or placebo therapy. For four weeks, participants were instructed for 30 minutes every week. Following therapy, the benefits of treatments were assessed by evaluating muscular strength, range of motion, muscle tone, grip strength, hand dexterity, and functional independence. Using the Dualer IQ Inclinometer and Modified Ashworth Scale, the MT group demonstrated substantially greater muscle strength, range of motion, and muscle tone of the wrist flexor than the placebo therapy group (p 0.05). In addition, the MT group demonstrated a significant improvement in grasp strength, hand dexterity, and functional independence compared to the placebo therapy group, as measured by the electro dynamometer, the Box and Block Test, and the Functional Independence Measure (p 0.05). Researchers concluded that MT could result in advantageous motor recovery enhancements in the upper extremities. The mirror therapy regimen described in this study is beneficial for upper extremity functional recovery following a CVA (J.-H. Kim & Lee, 2017).

In addition, another randomized controlled trial examined the effectiveness of MT in conjunction with a CPT program on the motor and functional recovery of CVA patients' upper extremities. Thirty-one hemiplegic patients were enrolled. Random assignment of the patients to the mirror (n = 16) or control (n = 15) groups. All patients received four weeks of CPT (60–120 minutes per day, five days per week) across all categories. The mirror group received MT, which consisted of periodic wrist and finger flexion and extension motions. In the traditional group, patients performed identical exercises against the mirror's side that did not reflect light. A blinded assessor evaluated the patients' Brunnstrom stage, FMA-UE score, and FIM self-care score at the start and at the end of therapy. The post-treatment scores of the MT group were considerably higher compared with those of the control group. In conclusion, Gurbuz et al. (2016) found that the addition of MT to a specific rehabilitation program enhanced the motor enhancements of the upper extremity in CVA patients (Gurbuz et al., 2016).

In addition, Lim et al. (2016) examined the influence of mirror therapy on ADLs and functional tasks in subacute CVA patients. Randomly, two groups of participants were formed.: the group receiving MT (30 patients) and the group receiving placebo therapy (30 patients). The MT group participated in an MT program in addition to traditional therapy for four weeks, 20 minutes per day, five days per week. The control group, like the MT group, received a sham CPT. The Fugl-Meyer Motor Function Assessment, Brunnstrom motor recovery stage, and Modified Barthel Index were evaluated four weeks after therapy. In both groups, the intervention dramatically improved upper extremity function on the afflicted side as well as ADL performance. Four weeks after intervention, the MT group improved significantly more on the FMA ($p = 0.027$) and MBI ($p = 0.041$) than the sham therapy group (Lim et al., 2016).

In addition, a study investigated the effects of MT with tasks on the function and self-care of CVA patients' upper extremities. Thirty individuals were designated into two groups at random (experimental, n = 15, and control, n = 15). For six weeks, the experimental group had MT with tasks five days per week, whereas the control group underwent placebo treatment. The Manual Function Test for the incapacitated upper limb and the FIM for self-care performance were the primary outcome measures. The experimental group had greater gains in change scores following the intervention than the control group. Conclusion: MT with tasks is beneficial for the upper extremity function and self-care of CVA patients (Y. Park et al., 2015).

Another study examined the effects of MT on the upper-extremity function and ADLs of chronic CVA patients. Randomization was used to assign 15 subjects to groups undergoing MT or placebo therapy. The Fugl-Meyer Motor Function Assessment and the Box and Block Test were used to evaluate the upper-extremity function and hand coordination of paretic individuals. The functional independence test was administered to evaluate an individual's capacity to perform daily tasks. Hand coordination and upper-extremity function differed substantially between the mirror therapy and placebo therapy groups for patients with paralysis. The MT group was superior to the sham treatment group in terms of enhancing ADL performance. Self-care differed significantly between mirror therapy and placebo therapy groups. Park et al. (2015) determined that MT is beneficial for improving the function and ADLs of chronic CVA patients with paretic upper extremities. (J.-Y. Park et al., 2015).

CHAPTER III

3.0 Methodology

3.1 Study Approach:

This randomized control trial focused to find out the effect of MT in improving motor function of upper extremity in chronic hemiplegic subjects.

3.2 Study Design:

Randomized Control Trial (Pre-test-post-test)

3.3 Ethical Consideration:

The research was performed after receiving the Institutional ethical committee approvals from the following hospitals: King Saud Medical City (KSMC); IRB number (H1RE-24-May22-02), Aljouf Health Affairs; IRB number (2022-18) and Prince Sultan Bin Abdulaziz Humanitarian City (SBAHC); IRB number (84-2022-IRB).

3.4 Study Setting:

The research was conducted at KSMC, Hospitals of Aljouf Health Affairs and SBAHC.

3.5 Study Population:

Thirty-eight chronic hemiplegic subjects were included.

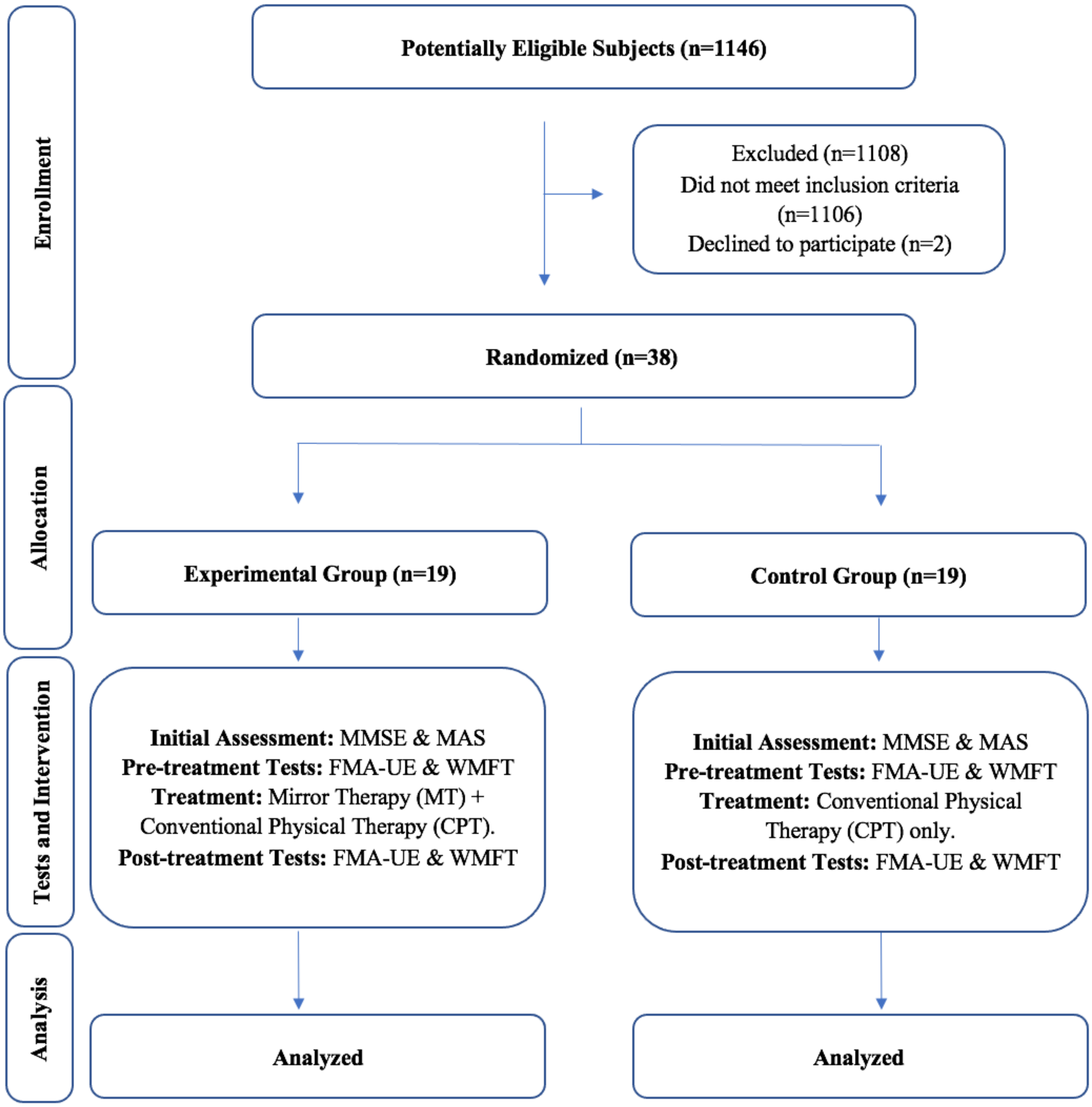


Figure 1: Flow Diagram for Randomized Subject Assignment in Current Study.

3.5.1 Inclusion Criteria: The following subjects were included:

- Duration of stroke more than six months
- Subjects of chronic stroke with left or right hemiplegia.
- Genders of male and female with age ranging between forty-five to sixty-five years.
- MMSE scores greater than 23 out of 30.
- Scored one or one plus on MAS on all muscles of the affected upper limb.
- Have normal visual perception.
- Able to follow oral commands.

3.5.2 Exclusion Criteria: The following subjects were excluded:

- Unable to follow visual and oral commands.
- Unilateral neglect.
- Cognitive impairments (MMSE scores less than 24 out of 30), or language deficits.
- Any other neurological disorders and recent surgeries.
- Previous exposure to MT.

3.6 Sampling Technique:

Non-probability convenience sampling technique. Sampling is the process of selecting a portion of the population to represent the entire population. Convenience sampling entails using the most conveniently available people as participants (Polit & Beck, 2010).

3.7 Sample and Sample Size:

Based on the previous study (Chinnavan et al., 2020) we calculated sample size of the current study. The following method was applied to obtain the size of the sample. And the sample size we got was 19 in each group making a **total sample required for the study as 38.**

$k=n2/n1=1$

$n1=(\sigma21+\sigma22/K)\ (z1-\alpha/2+z1-\beta)2/\Delta2$

$n1=(12.012+12.012/1)\ (1.96+0.84)2/112$

$n1=19$

$n2=K*n1=19$

$\Delta = |\mu2-\mu1|$ = definitive variation between two averages

$\sigma1, \sigma2$ = difference of average #1 and #2 n1 = number of participants in group one

n2 = number of participants in group two

α = Type one error possibility (usually 0.05)

β = Type two error possibility (usually 0.2)

z = Typical Z value for the provided alpha and beta

k = Number of participants ratio between the group two and group one.

3.8 Data Collection Tools and Techniques:

The demographic details were collected on data entry sheet and a detailed physical therapy neurological MMSE and MAS before the treatment. The primary evaluation methods of this research were FMA-UE and WMFT. All subjects were evaluated two times, first at the starting of the intervention and second after six weeks at the end of the intervention.

3.8.1 Materials:

3.8.1.1 Instrumentations:

- Mirror box or full-length mirror (14.8 x 14 x 1 inches)
- Chairs
- Tables (depending on activity)
- Quiet environment with limited visual and auditory distractions

3.8.1.2 Assessment Tools:

1- **Mini-Mental State Examination (MMSE):**

The examination of Mini-Mental Status that is known with the abbreviation (MMSE) is the most popular and widely tool utilized short examination to comprehensively gauge cognitive impairment in medical, research, and community fields (Arevalo-Rodriguez et al., 2015).

2- **Modified Ashworth Scale (MAS):**

The modified Ashworth Scale is the existing global norm for the clinical evaluation of spasticity of the extremities and the most widely utilized tool for assessing the effectiveness of pharmacological and rehabilitation interventions for the administration and therapy of spasticity in individuals with neurological disorders. The modified Ashworth Scale is a very dependable and valid measurement tool of spasticity, particularly in patients with stroke (Harb & Kishner, 2022).

3.8.1.3 Study Outcome Measures:

1- Fugl-Meyer Assessment Upper Extremity (FMA-UE):

The most widely applied method in post-stroke rehabilitation to estimate gross motor impairment is the FMA. It pursues the concept of stages of recovery for stroke patients, which developed with Twitchell and Brunnstrom. It gauges the capacity to manage isolated joints, which are impeded by synergy, and the strength of muscle, with an assumed order of difficulty. The components of the assessment are five including: joint range of motion (ROM), balance, sensory function, motion of the joint, and joint discomfort. FMA-UE is split into whole, proximal, and distal components and these subtests investigate the movement of body parts independently, with the authors recommending that every part of UE heal alone. It is used in the clinical field and in research to detect disease progress, prescribe exercise recovery, and prepare and evaluate medicine. FMA has as well demonstrated excellent inter- and intra-rater reliability, also the feasibility of construction. Moreover, FMA is practical in every stage of recovery from acute to chronic (H. Kim & Shin, 2022).

Wolf Motor Function Test (WMFT):

This examination tool was designed to estimate and evaluate the exercise capacity of individuals who suffer from mild to acute upper extremity motion impairments in laboratory and clinical settings. It is an improvement of a previous examination tool utilized in high-functioning patients, but difficult to perform in patients with minimal capacity of movement in the hands and fingers. WMFT has proven its significance in describing motion status in terms of severity and upper extremity motion impairments in a cohort of chronic individuals who suffer from stroke and traumatic brain injury in high-functioning individuals. The inter-test and inter-rater reliability, internal consistency of tests, and stability for schedule measures of performance and functional ability were high, varying from 0.88 to 0.98, with most estimates' relative from 0.95 (Taub et al., 2011).

3.9 Procedure:

The research was performed after receiving the Institutional ethical committee approvals. Convenience sampling was used for the recruitment of chronic hemiplegic subjects. After a careful monitor of inclusion and exclusion criteria the study procedure were clearly explained to the subjects. The selected subjects were asked to provide oral and written informed consent for their participation in the research. The subjects of the study were allocated randomly to both groups (experimental and control) by lottery method.

The cluster of control participants received the CPT based on their routine physical therapy neurological evaluation. The CPT was individualized based on the need of the subjects. It included: normalization of muscle tone, strengthening of weak muscles, lengthening of tight muscles, training for transfers like supine to sit, sit to stand, balance training, and gait training. The upper extremity training for ADLs also were incorporated using mobilization, reaching, grasping and dexterity movements. The experimental group received combination therapy that is MT combined with CPT treatment. The details about the process of MT treatment were clearly explained to the subjects. Furthermore, subjects were advised to be mentally engaged in this kind of treatment and while performing the movement they were instructed to think that the mirror reflecting image of the normal extremity is their affected one. The subjects were asked to be seated on a comfortable chair with feet and back supported and the upper extremity was on the tabletop surface of two-by-two- meter size.

Mirror was positioned anterior to the subjects so that the involved upper extremity is completely shielded by the mirror and the image of the un-involved upper extremity was completely seeable. The involved upper extremity was placed in a relaxed and unharmful posture beside the mirror. The un-involved upper extremity was placed in the same posture of involved upper extremity. This kind of upper extremity positioning will improve the illusional movements of the involved upper extremity. The MT in the experimental group involved reaching, grasping and dexterity movements of the unaffected upper limb followed by the imitation in the involved upper extremity. Subjects were instructed to perform five different activities that is first finger flexion and extension, second finger opposition, third counting with fingers, fourth is wrist flexion and extension and fifth is forearm supination and pronation. In order to aid the involved side, these activities were done 10 times, and the total duration for mirror therapy was 15 minutes followed by 30 minutes of CPT treatment. The treatment session for both the groups lasted for 45 minutes with three sessions per week and the total duration of the intervention will be six weeks.

*Demonstration of the five activities of MT Program can be found in the appendix 13.

3.10 Data Analysis:

Twenty eighth version of the Statistical Package for the Social Science (SPSS) was utilized for the analyzing of the research results. The confidence interval was kept at 95% and level of significance measured by p value was kept at the < 0.05. Univariate analysis of the demographic characteristics like age, gender distribution, duration of the stroke, height, weight, body mass index etc. were done by using the descriptive statistics. The differences between the pre- and post-measurements for FMA-UE, and WMFT for each group were analyzed by using the Wilcoxon Signed Ranks Test. The differences between the control and experimental group outcome measures like FMA-UE, and WMFT were assessed by the Mann Whitney U Test.

CHAPTER IV

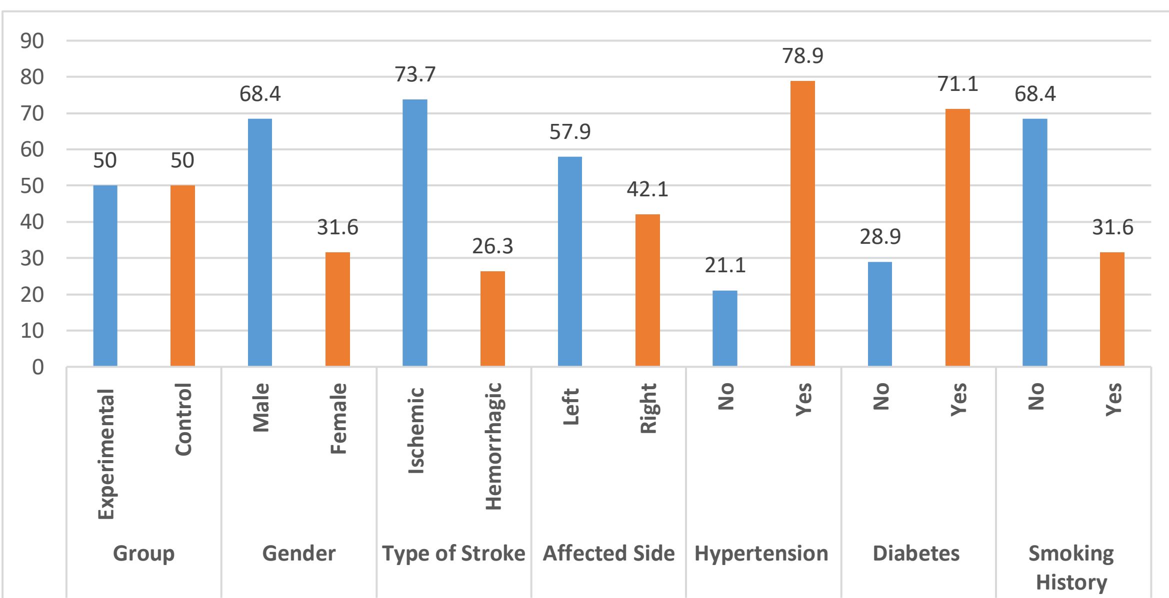
4.0 Results

Descriptive statistics including frequency and percentage were calculated for the demographic and clinical characteristics of the study population using SPSS version 28. The findings indicate that the study population consisted of 38 participants, divided equally into two groups: experimental and control. The majority of the participants were male (68.4%), and the most common type of stroke was ischemic (73.7%). Most of the participants had hypertension (78.9%) and diabetes (71.1%), while smoking history was present in 31.6% of the participants. The affected side of the stroke was left in 57.9% of the cases. The details are shown in Table 1 and Figure 2.

Table 1: Demographical and Clinical Characteristics of the study Population (n = 38).

Variable	**Category**	***f***	**%**
Group	Experimental	19	50.00
	Control	19	50.00
Gender	Male	26	68.4
	Female	12	31.6
Type of Stroke	Ischemic	28	73.7
	Hemorrhagic	10	26.3
Affected Side	Left	22	57.9
	Right	16	42.1
Hypertension	No	8	21.1
	Yes	30	78.9
Diabetes	No	11	28.9
	Yes	27	71.1
Smoking History	No	26	68.4
	Yes	12	31.6

Figure 2:* Graph Showing the *Demographical and Clinical Characteristics of the study Population



Note. *f* = frequency or number or count (of participants); % = percentage (of participants)

The descriptive statistics were calculated for demographic and clinical characteristics, including mean, median, standard deviation, range, minimum, and maximum. The results indicated that the sample consists of participants with a mean age of 54.97 years, with a range of 20 years, and a standard deviation of 7.11. The mean duration of the intervention was 20.24 months, ranging from 6 to 168 months. The participants had a mean weight of 78.92 kg and a mean height of 165.66 cm, resulting in a mean BMI of 28.71.

The cognitive and motor assessments of the participants were also measured. The mean score of the Mini-Mental State Examination was 26.50 out of 30, with a standard deviation of 2.39. The mean score of the Motor Assessment Scale was 1.18, ranging from 1.0 to 1.5, with a standard deviation of 0.24.

The pre- and post-intervention results for the upper extremity motor function were measured using the Wolf Motor Function Test and Fugl-Meyer Assessment-Upper Extremity. The mean score of the WMFT-T improved from 49.05 to 43.12, and the mean score of WMFT-FA improved from 37.21 to 48.66 post-intervention. The mean score of FMA-UE improved from 83.34 to 94.53 post-intervention. In summary, the results suggest that the intervention was effective in improving the motor function of the upper extremities in the study participants. The details are shown in Table 2.

Table 2: Descriptive Statistics for Demographic and Clinical Characteristics of the Study Population (n=38).

Variables	Mean	Median	SD	Range	Minimum	Maximum
Age	54.97	55.00	7.11	20.00	45.00	65.00
Duration in Months	20.24	10.00	28.88	162.00	6.00	168.00
Weight (kg)	78.92	75.65	18.95	76.80	38.20	115.00
Height (cm)	165.66	167.00	11.21	43.00	150.00	193.00
BMI	28.71	28.55	6.19	24.66	16.96	41.62
Assessment of MMSE	26.50	26.50	2.39	6.00	24.00	30.00
Assessment of MAS	1.18	1.00	.24	.50	1.00	1.50
WMFT-T Pre-Intervention	49.05	3.91	58.08	119.02	.98	120.00
WMFT-T Post Intervention	43.12	2.43	56.42	119.35	.65	120.00
WMFT-FA Pre-Intervention	37.21	38.00	17.79	57.00	15.00	72.00
WMFT-FA Post Intervention	48.66	56.50	20.29	57.00	18.00	75.00
FMA-UE Pre Intervention	83.34	86.00	25.58	85.00	39.00	124.00
FMA-UE Post Intervention	94.53	104.00	24.98	81.00	44.00	125.00

Note. SD = Standard Deviation; BMI = Body Mass Index; MMSE = Mini-Mental State Examination; MAS = Motor Assessment Scale: WMFT-T = Wolf Motor Function Test-Time (Seconds); WMFT-FA = Wolf Motor Function Test-Factional Ability; FMA-UE = Fugl-Meyer Assessment for Upper Extremity.

To compare the experimental and the control group on various assessment tools for screening and outcome measures, the Mann-Whitney U tests were performed. The results indicated that the Assessment of MMSE scores did not significantly differ between the experimental and control groups ($U = 152.00$, $p = 0.388$). Similarly, there was no significant difference in the Assessment of MAS scores between the experimental and control groups ($U = 180.00$, $p = 0.999$). For the WMFT-T Pre-Intervention scores, there was no significant difference between the experimental and control groups ($U = 162.50$, $p = 0.587$). Further, the results indicated that in terms of WMFT-T Post Intervention scores there was no significant difference between control group and experimental group ($U = 157.00$, $p = 0.484$). The WMFT-FA Pre-Intervention scores did not significantly differ between the experimental and control groups ($U = 148.50$, $p = 0.350$). In contrast, the WMFT-FA Post Intervention scores were marginally significantly higher for the experimental group than the control group ($U = 115.00$, $p = 0.056$). For the FMA-UE Pre Intervention scores, there was no significant difference between the experimental and control groups ($U = 164.50$, $p = 0.640$). Similarly, there was no significant difference in the FMA-UE Post Intervention scores between the experimental and control groups ($U = 147.50$, $p = 0.335$). Overall, the results suggest that there was no significant difference between the groups on the measured outcomes. The details are shown in Table 3 and Figure 3.

Table 3: Comparison between Experimental and Control Groups on Various Assessment and Outcome Measures.

Conditions/Measures	**Group**	**N**	**Mean Rank**	**Mann-Whitney U**	***p***
Assessment of MMSE	Experimental	19	21.00	152.00	0.388
	Control	19	18.00		
Assessment of MAS	Experimental	19	19.50	180.00	0.999
	Control	19	19.50		
WMFT-T Pre-Intervention	Experimental	19	20.45	162.50	0.587
	Control	19	18.55		
WMFT-T Post Intervention	Experimental	19	18.26	157.00	0.484
	Control	19	20.74		
WMFT-FA Pre-Intervention	Experimental	19	17.82	148.50	0.350
	Control	19	21.18		
WMFT-FA Post Intervention	Experimental	19	22.95	115.00	0.056
	Control	19	16.05		
FMA-UE Pre Intervention	Experimental	19	18.66	164.50	0.640
	Control	19	20.34		
FMA-UE Post Intervention	Experimental	19	21.24	147.50	0.335
	Control	19	17.76		

Note. MMSE = Mini-Mental State Examination; MAS = Motor Assessment Scale: WMFT-T = Wolf Motor Function Test-Time (Seconds); WMFT-FA = Wolf Motor Function Test-Factional Ability; FMA-UE = Fugl-Meyer Assessment for Upper Extremity.

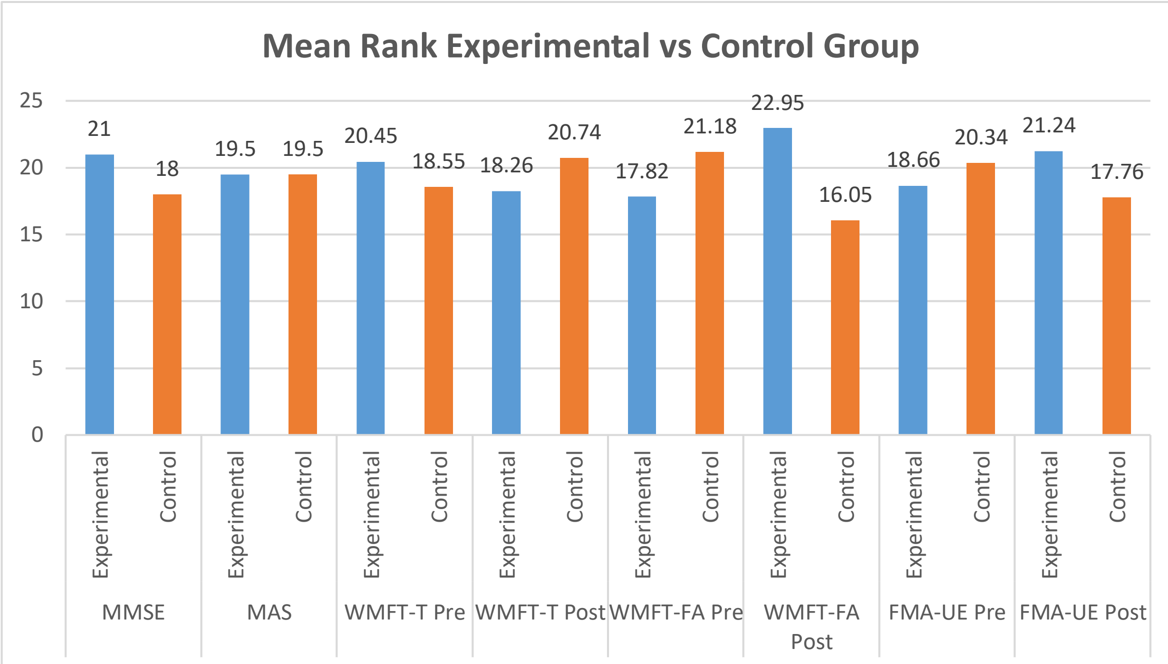


Figure 2: Graph Showing the Comparison Between Experimental and Control Groups on Various Assessment and Outcome Measures.

A Wilcoxon signed-rank test was conducted to compare the mean scores on the Wolf Motor Function Test-Time (WMFT-T) between pre-intervention (M = 40.31, SD = 55.63) and post-intervention (M = 28.62, SD = 49.01) among the experimental group of 19 stroke subjects. The mean rank of the pre-intervention scores was 0.00, while the mean rank of the post-intervention scores was 8.00. The difference in mean scores was statistically significant, z = -3.41, $p < .001$, indicating a significant improvement in motor function following the intervention. The median score for the pre-intervention was 3.83, while the median score for post-intervention was 2.27. The range of scores on the WMFT-T was from 1.08 to 120.00. The details are shown in Table 4 and Figure 4.

The Wilcoxon signed-rank test was used to analyze the difference between pre-intervention and post-intervention scores on the WMFT-FA measure among the experimental group of 19 stroke subjecs. Results showed a statistically significant difference in the scores before the treatment (M = 34.26) and after it (M = 54.74), z = -3.83, p < .001. The median score for the pre-intervention assessment was 39.00 and for the post-intervention assessment was 61.00, indicating a substantial improvement in fine motor function. Additionally, the mean rank for the pre-intervention scores was 10.00, and for the post-intervention scores was 0.00, suggesting that the post-intervention scores were significantly higher than the pre-intervention scores. The details are shown in Table 4 and Figure 5.

The results of the Fugl-Meyer Assessment of Upper Extremity (FMA-UE) pre- and post-intervention for the experimental group were analyzed using the Wilcoxon signed-rank test, with a significant decrease in z-score from pre-intervention to post-intervention (z = -3.82, p < .001), indicating that upper extremity motor function has improved statistically significantly. The mean FMA-UE score increased from 80.84 (SD = 24.12) pre-intervention to 99.63 (SD = 22.78) post-intervention. The median FMA-UE score also increased from 86.00 to 108.00, with interquartile ranges of 59.00-96.00 and

78.00-117.00 for pre- and post-intervention, respectively. The details are shown in Table 4 and Figure 6.

To compare the Outcome measure Wolf Motor Function Test-Time (Seconds) scores Pre and Post Intervention in control group, the Wilcoxon Signed Ranks Test was performed. Based on the Wilcoxon signed-rank test, there was a significant difference in the WMFT-T scores between pre-intervention (M = 57.78, SD = 60.65) and post-intervention (M = 57.63, SD = 60.79) conditions (z = -2.81, p = 0.005). The median score increased from 3.99 to 3.79 after the intervention, with a large range of scores observed (minimum = 0.98, maximum = 120). These findings suggest that in the control group the participants also indicated a significant improvement in motor function WMFT-T scores. The details are shown in Table 4 and Figure 4.

To compare the Outcome measure Wolf Motor Functional Test-Functional Ability scores Pre and Post Intervention in the control group, the Wilcoxon Signed Ranks Test was performed. The Wilcoxon signed-rank test indicated a statistically significant improvement in scores following the intervention (z = -3.32, p < .001). The pre-intervention mean score was 40.16 (SD = 21.27), while the post-intervention mean score was 42.58 (SD = 21.60). The study suggests that the intervention may have a positive effect on upper limb function, as measured by the WMFT-FA, in this sample of participants too. The details are shown in Table 4 and Figure 5.

To compare the Outcome measure Fugl-Meyer Assessment - Upper Extremity scores Pre and Post Intervention in control group, the Wilcoxon Signed Ranks Test was performed. The Wilcoxon signed-rank test indicated a statistically significant improvement in scores following the intervention ($z = -3.83$, $p < .001$). The pre-intervention mean score was 85.84 (SD = 27.39), while the post-intervention mean score was 89.42 (SD = 26.62). The study suggests that the intervention may have a positive effect on upper extremity function, as measured by the FMA-UE, in this sample of participants too. The details are shown in Table 4 and Figure 6.

Table 4: Comparison between Experimental and Control Groups based on pre- and post-intervention in terms of Outcome Measures.

Measures	Group	Condition	N	M	Mean Rank	Wilcoxon signed-rank test	*p*
WMFT-T	Experimental	Pre	19	40.31	0.00	-3.41	<.001
		Post	19	28.62	8.00		
	Control	Pre	19	57.78	0.00	-2.81	.005
		Post	19	57.63	5.50		
WMFT-FA	Experimental	Pre	19	34.26	10.00	-3.83	<.001
		Post	19	54.74	0.00		
	Control	Pre	19	40.16	7.50	-3.32	<.001
		Post	19	42.58	0.00		
FMA-UE	Experimental	Pre	19	80.84	10.00	-3.82	<.001
		Post	19	99.63	0.00		
	Control	Pre	19	85.84	10.00	-3.83	<.001
		Post	19	89.42	0.00		

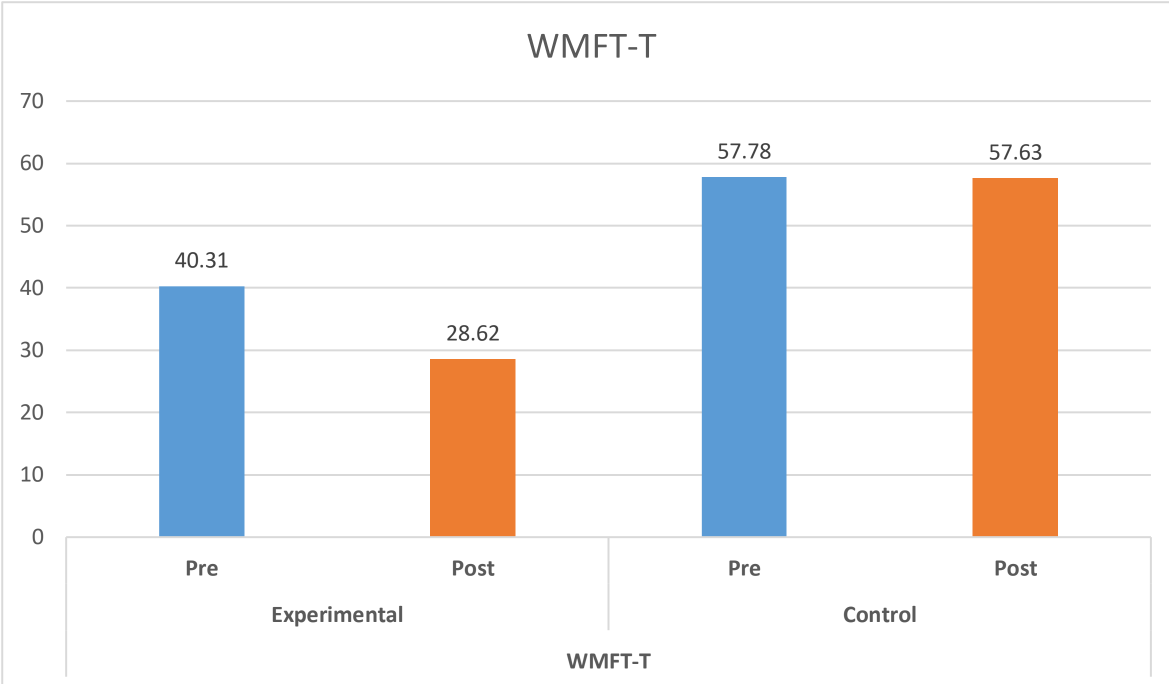


Figure 4: Graph showing the comparison of Experimental and Control Groups in terms of WMFT-T.

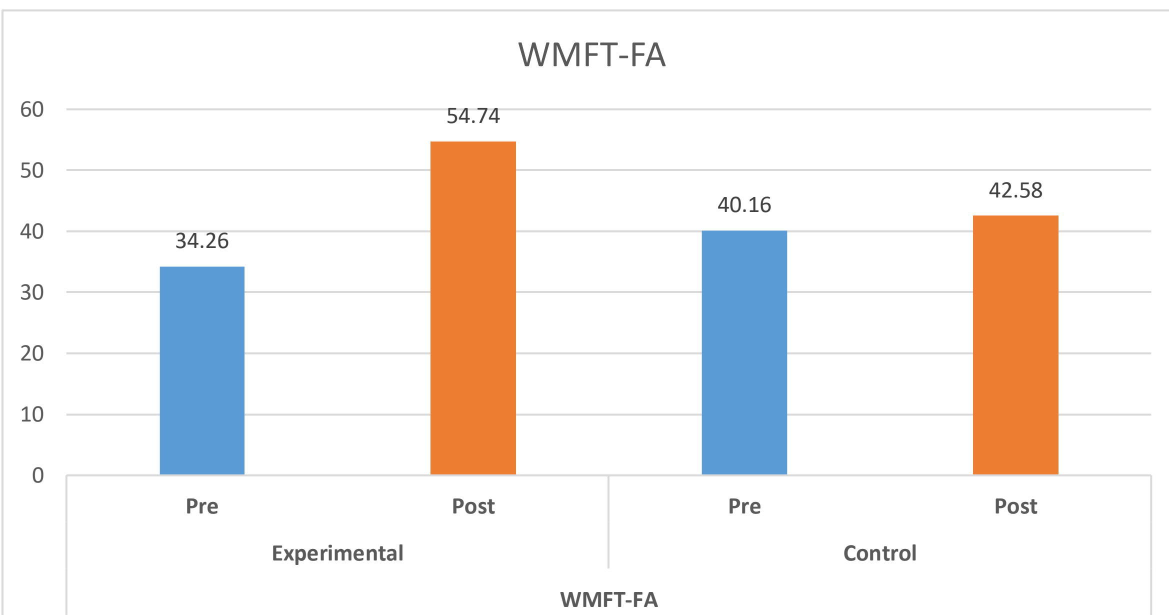


Figure 3: Graph showing the comparison of Experimental and Control Groups in terms of WMFT-FA.

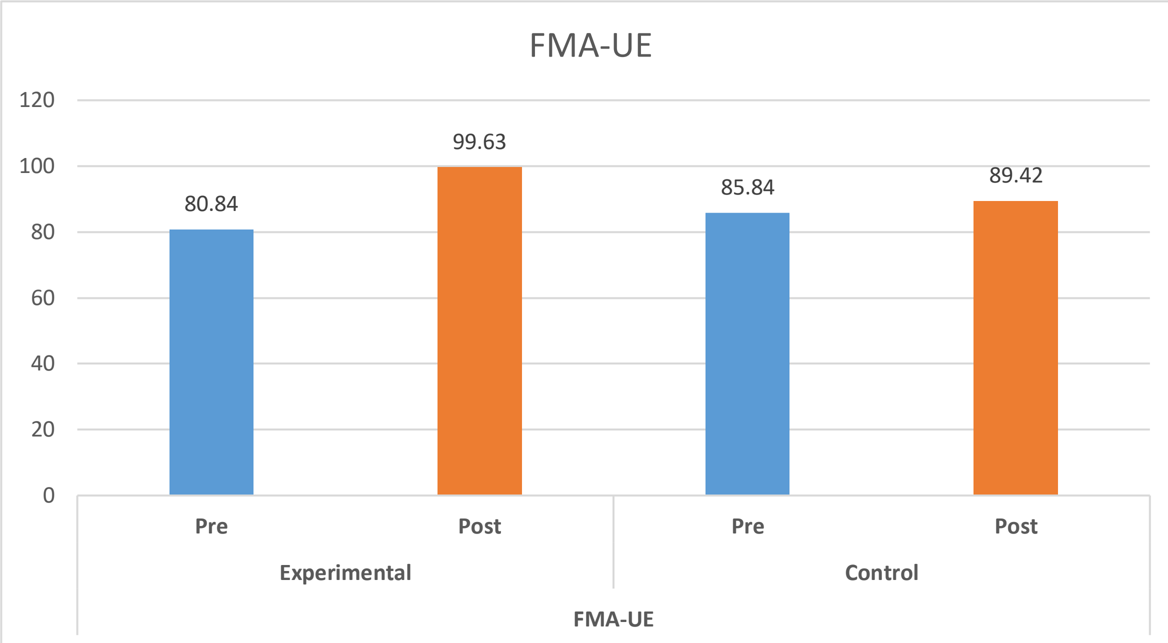


Figure 5: Graph showing the comparison of Experimental and Control Groups in terms of FMA-UE.

To compare the mean differences of post to pre interventions between the experimental and the control group on various outcome measures, the Mann-Whitney U tests were performed. All the outcome measures like WMFT-T, WMFT-FA, and FMA-UE mean differences between pre to post intervention had shown statistically significant differences with level of significance < 0.001. This indicates that the overall upper extremity function and impairments evaluated by WMFT-T, WMFT-FA, and FMA-UE had significantly improved with the experimental group interventions than control group interventions. The details are shown in Table 5 and Figure 7.

Table 5: Comparison between Experimental and Control Groups on mean differences of WMFT-T, WMFT-FA, and FMA-UE pre to post interventions.

Conditions/Measures	Group	N	Mean Rank	Mann-Whitney U	*p*
WMFT-T mean difference of pre to post intervention	Experimental	19	25.79	61.00	<0.001
	Control	19	13.21		
WMFT-FA mean difference of pre to post intervention	Experimental	19	28.92	1.5	<0.001
	Control	19	10.98		
FMA-UE mean difference of pre to post intervention	Experimental	19	28.32	13	<0.001
	Control	19	10.68		

Note. WMFT-T = Wolf Motor Function Test-Time (Seconds); WMFT-FA = Wolf Motor Function Test-Factional Ability; FMA-UE = Fugl-Meyer Assessment for Upper Extremity.

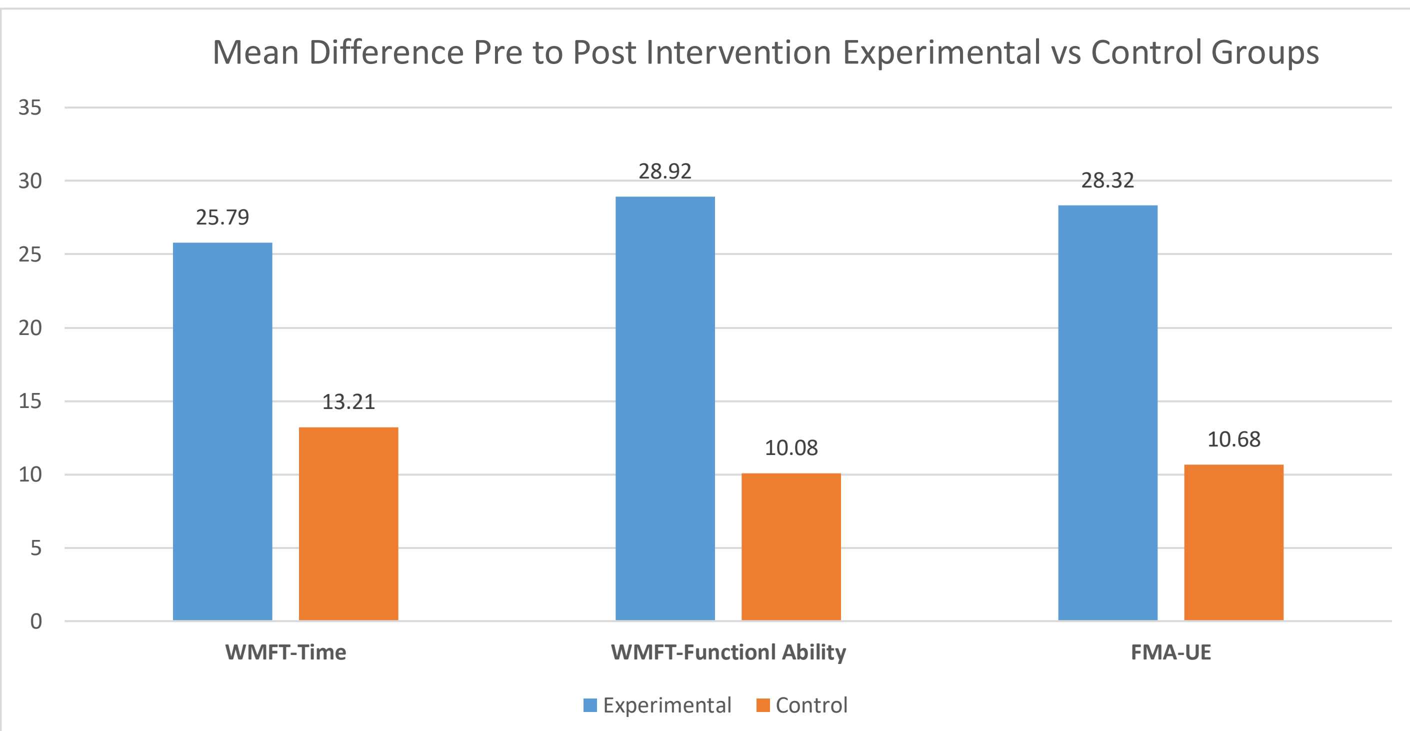


Figure 6: Graph showing the comparison between Experimental and Control Groups on mean differences of WMFT-T, WMFT-FA, and FMA-UE pre to post interventions.

CHAPTER V

5.0 Discussion

The current study is one of the unique studies conducted on the stroke population in the Kingdom of Saudi Arabia. As per our literature, this is one of the first studies conducted to see the effect of MT on improving upper extremity motor function here. The present research also found interesting improvements in the experimental group on upper extremity impairments assessed by the FMA-UE scale and motor function assessed by WMFT. The combination of CPT and MT provided superior improvements in chronic stroke upper extremity function in comparison to the CPT alone in the control group.

Chan and Au-Yeung conducted a study similar to the current one on the stroke population, and their outcomes were like current study. In their study, the FMA-UE scale scores of the MT group were changed from pre- to post-intervention with a mean (SD) of 19.2(16) to 34.4(18.9), respectively, and in the control group, they were changed from pre- to post-intervention with a mean (SD) of 21.7(15.1) to 38(18.2) respectively (Chan & Au-Yeung, 2018). In the current study, the FMA-UE scale scores of the MT group were changed from pre- to post-intervention with a mean (SD) of 80.84(24.12) to 99.63(22.78), respectively, and in the control group, they were changed from pre- to post-intervention with a mean (SD) of 85.84(27.39) to 89.42(26.62) respectively.

Along with the FMA-UE scale, the Chan and Au-Yeung study also has WMFT, both time and functional ability scores, as an outcome measure. In their study, the WMFT time scores of the MT group were changed from pre- to post-intervention with a mean (SD) of 92.2 (37.8) to 61.7(44.9), respectively, and in the control group, they were changed from pre- to post-intervention with a mean (SD) of 77.6(39.2) to 49.4(39.2) respectively (Chan & Au-Yeung, 2018). Whereas, in the current study, the WMFT time scores of the MT group were changed from pre- to post-intervention with a mean (SD) of 40.31 (55.63) to 28.62(49.01), respectively, and in the control group, they were changed from pre- to post-intervention with a mean (SD) of 57.78(60.65) to 57.63(60.79) respectively.

The WMFT functional ability scores assessed by Chan and Au-Yeung study were of average values of 0-5 Likert scale; thus, their scores ranged between 0-5, whereas the current study had measured WMFT functional ability scores as a total of all the question not as mean resulting in the scoring of 0-75. In their study, the WMFT functional ability scores of the MT group were changed from pre- to post-intervention with a mean (SD) of 1.4 (0.6) to 2.5(1.4), respectively. In the control group, they were changed from pre- to post-intervention with a mean (SD) of 1.8(0.7) to 2.8(1.4), respectively (Chan & Au-Yeung, 2018). Whereas, in the current study, the WMFT functional ability scores of the MT group were changed from pre- to post-intervention with a mean (SD) of 34.26 (13.40) to 54.74(17.36), respectively, and in the control group, they were changed from pre- to post-intervention with a mean (SD) of 40.16(21.27) to 42.58(21.16) respectively.

Both the control and experimental groups improved significantly from pre- to post-interventions in both studies on FMA-UE, WMFT-T, and WMFT-FA with p value < 0.05. However, the Chan and Au-Yeung study did not show a significant difference between the control and experimental groups' mean pre- and post-intervention differences (Chan & Au-Yeung, 2018). In contrast, the current study showed a statistically significant difference between the group's mean differences of pre to post-interventions for all three outcome measures, that is, FMA-UE, WMFT-T, and WMFT-FA. The reasons for these differences could be due to the following reasons. First, the duration of the treatment in the current study was six weeks, and in the comparison study, it was only four weeks. Second, the mean age of the subjects involved in the current study was 54.97 (7.11), whereas the mean age of the subjects involved in the comparison study was 65.3 (11.8). Third, the duration of stroke in the current study was chronic cases with a mean of 20.24 (28.88) months, whereas the duration of the stroke in the comparison study was acute with a mean of 13.9 (6.7) days. Hence the probable reasons for these differences could be attributed to the duration of intervention, age of the subjects and duration of stroke involved in both studies.

The current study's WMFT-FA and FMA-UE scores were compared to three previous studies conducted on the stroke population using MT as a treatment intervention. In the first study by (Waghavkar & Ganvir, 2015), the FMA-UE scores were very low compared to current study because they took only the hand component of FMA-UE. In contrast, in the current study, we have considered all the FMA-UE scores, which total 126; there is a huge difference in the numbers. Similarly, even in the WMFT-FA, the mean scores were low in Waghavkar and Ganvir's study; this is also due to testing only hand components of the WMFT-FA scale than the whole scale score, which is a total of 75 scores. Moreover, the subjects included in the Waghavkar and Ganvir study were of acute and sub-acute populations, and in current study, the subjects were of chronic stroke. However, there is a statistically significant improvement in both the studies' experimental groups, pre- and post-MT intervention, with a p-value < 0.05.

The second study by (Bai et al., 2019) was conducted on the stroke population using MT and they had three groups in their study. In group one, the intervention was movement-focused MT (MMT); in group two, the intervention was task-focused MT (TMT); and in the third group was a control group including conventional physical therapy. However, the mean scores of FMA-UE were lower in number than in the current study because, in this study also, the total score considered for FMA-UE was 66. In contrast, in the current study, current study included all the components of the FMA-UE scale that scored 126.

However, the Bai et al. study only had statistically significant improvements in the FMA-UE score and not in the other outcomes, including WMFT-FA. Current study had significant improvements in both scales, which can be attributed to the following reasons. First, the duration of the treatment in the current study was six weeks, with each session 45 minutes, and in the Bai et al. study, it was only four weeks, with each session 30 minutes. Second, the age of the subjects involved in the current study was with in 65 years, whereas the age of the subjects involved in the Bai et al. study was greater than 65 years, and as the age increases, the chances of improvements will become less in the stroke population (Ashrafi et al., 2022; Bai et al., 2019; Paolucci et al., 2003). Third, the duration of stroke in the current study was chronic cases with a mean of 20.24 (28.88) months, whereas the duration of the stroke in the Bai et al. study was acute and sub-acute, ranging from two to three months in both the groups. Hence, the probable reasons for these differences could be attributed to the duration of intervention, the subjects' age, and the stroke duration involved in both studies.

Another interesting phenomenon observed in comparing the two studies was improvements in the outcome measures. In the (Bai et al., 2019) study, there were improvements only in the FMA-UE scale than remaining all the scales. The FMA-UE majorly focuses on the impairment section of the ICF model than the activity and participation. Hence, the intervention was only four weeks with half an hour of treatment on the older acute stroke population. Their improvements were limited in enhancing impairments alone. Whereas, in the current study, the six weeks of 45 minutes interventions on a comparatively younger aging population combining MT and CPT would have improved the functional level and the impairment level of outcomes.

In the third study conducted by (Yoon et al., 2014) the MT group WMFT-FA scores and FMA-UE scores were similar to that of the current study experimental group values and improvements. Moreover, combining CIMT, CPT, and MT enhanced the effect and led to improvements. These improvements could be due to the intensive therapy of seven hours and ten minutes of training, including two hours in the physical therapy ward and four hours of in-patient rehabilitation therapy CIMT plus 30 minutes of MT and another 40 minutes of CPT leading to improvements. More details of the individual studies' WMFT-FA and FMA-UE scores can be found in the appendix 14.

Current study has compared eight studies' effects of MT on stroke subjects with upper extremity impairments measured by the FMA-UE scale (Lin et al., 2014; Manzoor et al., 2021; Michielsen et al., 2011; Pan et al., 2021; Prasetyaningsih & Kurniawan, 2021; Nelakurthy et al., 2021; Wu et al., 2013; Zhang et al., 2021). Compared to current study, all the remaining studies had fewer total scores and their post FMA-UE minimum to maximum mean±SD scores were ranging from 20.0 ± 5.1 to 60.13 ± 3.27. Whereas, in the current study post FMA-UE mean±SD scores ranging from 89.42 ± 26.62 to 99.63 ± 22.78 and these differences were possibly due to the following reasons. Most of them considered acute and sub-acute cases, whereas current study considered chronic cases. Second, most of the studies did not consider whole FMA-UE scores like current study, where it had considered a total score of 126 for evaluation. In contrast, the comparison studies considered only part of the scale scores. Third, the duration of intervention in most of the studies was four weeks compared to current study, where it had six weeks. Finally, as in most comparison studies, current study experimental group combined CPT with MT. More details of the individual studies' FMA-UE scores can be found in the appendix 15.

As per the above discussion, the researcher noticed that the MT compared to CPT had special effects. As per another study (Hamzei et al., 2020), the anatomical basis of mirror therapy improvements studied on MRI and fMRI revealed the following improvements. They observed an activation of the sensory-motor cortex during passive movements and actions of the affected limb. At the same time, MT fMRI found activation of the ventral premotor cortex and Broadman area number 46, 45, and 44. This indicates neuronal activation during the MT and is a potential reason for establishing new neuronal connections.

The fundamental principle of neuromodulation in MT was the activation of mirror bimodal visuomotor neurons. When a person sees the movement of normal extremities on the affected side, mirror it will cause activation of these mirror neurons in the primary motor cortex and thus facilitating the neuronal connections required for these movements. Repeated practice of this movement will reorganize the neuronal connections and enhance the movement potentials (Jaafar et al., 2021; Prasetyaningsih & Kurniawan, 2021).

The researcher believe the CPT used in the current study has fixed musculoskeletal issues like muscle tightness, lack of range of motion, spasticity, and muscle strength concerns. After managing these physical issues, practicing neuronal training by mirror therapy would have complimented the improvement resulting in enhancement of the motor function.

CHAPTER VI

6.0 Conclusion

Six weeks of 18 sessions of control group (CPT treatment) and experimental group (MT combined with CPT treatments) of 45 minutes sessions were effective in improving impairments and functions among the chronic stroke subjects. However, when comparing the experimental group with the control group, the improvements in the FMA-UE scores, WMFT time, and functional ability scores were statistically significant with a p-value < 0.05. This indicates that combining CPT with adjuvant therapies like MT can obtain promising recovery among chronic hemiplegic subjects regarding upper extremity impairments and motor function.

6.1 Limitations and Future Suggestions

This study was focused on chronic cases, and most of the previously conducted studies were on acute and sub-acute stroke cases; however, the chronic stroke subjects immediately after six months were rarely studied; hence future studies can consider this population to see the effects of MT. Moreover, the Mirror therapy was conducted only for the Upper extremity, and as per the current recommendations, it can apply to the lower extremity also and which can be studied in upcoming studies. The outcome measures used were more of measuring impairments and functional components;

however, as per the ICF model incorporating the participation and quality of life measurements may provide a more detailed understanding of MT. Furthermore, currents study lacks post-study follow-up, and future authors should consider the post-study follow-up to see the maintenance of function post-treatment period.

References

Alhazzani, A. A., Mahfouz, A. A., Abolyazid, A. Y., Awadalla, N. J., Aftab, R., Faraheen, A., & Khalil, S. N. (2018). Study of stroke incidence in the aseer region, southwestern Saudi Arabia. *International Journal of Environmental Research and Public Health*, *15*(2). https://doi.org/10.3390/ijerph15020215

Alqahtani, B. A., Alenazi, A. M., Hoover, J. C., Alshehri, M. M., Alghamdi, M. S., Osailan, A. M., & Khunti, K. (2020). *Incidence of stroke among Saudi population: a systematic review and meta-analysis*. https://doi.org/10.1007/s10072-020-04520-4/Published

Antoniotti, P., Veronelli, L., Caronni, A., Monti, A., Aristidou, E., Montesano, M., & Corbo, M. (2019). No evidence of effectiveness of mirror therapy early after stroke: an assessor-blinded randomized controlled trial. *Clinical Rehabilitation*, *33*(5), 885–893. https://doi.org/10.1177/0269215518824737

Arevalo-Rodriguez, I., Smailagic, N., Roquéi Figuls, M., Ciapponi, A., Sanchez-Perez, E., Giannakou, A., Pedraza, O. L., Bonfill Cosp, X., & Cullum, S. (2015). Mini-Mental State Examination (MMSE) for the detection of Alzheimer's disease and other dementias in people with mild cognitive impairment (MCI). In *Cochrane Database of Systematic Reviews* (Vol. 2015, Issue 3). John Wiley and Sons Ltd. https://doi.org/10.1002/14651858.CD010783.pub2

Arfianti, L., Rochman, F., Hidayati, H. B., & Subadi, I. (2022). The addition of mirror therapy improved upper limb motor recovery and level of independence after stroke: a randomized controlled trial. *Brazilian Journal of Occupational Therapy*, *30*. https://doi.org/10.1590/2526-8910.ctoAO245932182

Ashrafi, S., Mehr, M. S., Mohammadi, T. K., Jafroudi, S., & Leyli, E. K. (2022). Effect of Mirror Therapy on the Motor Recovery in Patients After Stroke: A Randomized Clinical Trial. *Iranian Rehabilitation Journal*, *20*(1), 65–78. https://doi.org/10.32598/irj.20.SpecialIssue.1519.1

Bai, Z., Zhang, J., Zhang, Z., Shu, T., & Niu, W. (2019). Comparison Between Movement-Based and Task-Based Mirror Therapies on Improving Upper Limb Functions in Patients With Stroke: A Pilot Randomized Controlled Trial. *Frontiers in Neurology*, *10*. https://doi.org/10.3389/fneur.2019.00288

Bakraa, R., Aldhaheri, R., Barashid, M., Benafeef, S., Alzahrani, M., Bajaba, R., Alshehri, S., & Alshibani, M. (2021). Stroke risk factor awareness among populations in Saudi Arabia. *International Journal of General Medicine*, *14*, 4177–4182. https://doi.org/10.2147/IJGM.S325568

Beltrán-Rodríguez, I., Casado, L. G. T., Durán-Borrella, Ó., González-Feito, P., Sánchez-Serrano, I., & de la Fuente Blanco, R. (2022). Post-Stroke Rehabilitation: A Necessary Step.

Chan, W. C., & Au-Yeung, S. S. Y. (2018). Recovery in the Severely Impaired Arm Post-Stroke after Mirror Therapy: A Randomized

Controlled Study. *American Journal of Physical Medicine and Rehabilitation*, *97*(8), 572–577. https://doi.org/10.1097/PHM.0000000000000919

Chinnavan, E., Priya, Y., Ragupathy, R., & Wah, Y. C. (2020). Effectiveness of mirror therapy on upper limb motor functions among hemiplegic patients. *Bangladesh Journal of Medical Science*, *19*(2), 208–213. https://doi.org/10.3329/bjms.v19i2.44997

De Luca, A., Squeri, V., Barone, L. M., Vernetti Mansin, H., Ricci, S., Pisu, I., Cassiano, C., Capra, C., Lentino, C., De Michieli, L., Sanfilippo, C. A., Saglia, J. A., & Checchia, G. A. (2020). Dynamic Stability and Trunk Control Improvements Following Robotic Balance and Core Stability Training in Chronic Stroke Survivors: A Pilot Study. *Frontiers in Neurology*, *11*. https://doi.org/10.3389/fneur.2020.00494

Dohle, C., Püllen, J., Nakaten, A., Küst, J., Rietz, C., & Karbe, H. (2009). Mirror therapy promotes recovery from severe hemiparesis: A randomized controlled trial. *Neurorehabilitation and Neural Repair*, *23*(3), 209–217. https://doi.org/10.1177/1545968308324786

Fong, K., Ting, K. H., Chan, C., & Li, L. (2019). Mirror therapy with bilateral arm training for hemiplegic upper extremity motor functions in patients with chronic stroke. In *Hong Kong Med J* /(Vol. 25, Issue 1). www.hkmj.org

Gandhi, D. B. C., Sterba, A., Khatter, H., & Pandian, J. D. (2020). Mirror therapy in stroke rehabilitation: Current perspectives. In *Therapeutics and Clinical Risk Management* (Vol. 16, pp. 75–85). Dove Medical Press Ltd. https://doi.org/10.2147/TCRM.S206883

Gurbuz, N., Afsar, S. I., Ayaş, S., Nur, S., & Cosar, S. (2016). *Effect of mirror therapy on upper extremity motor function in stroke patients: a randomized controlled trial*.

Habibi-Koolaee, M., Shahmoradi, L., Niakan Kalhori, S. R., Ghannadan, H., & Younesi, E. (2018). Prevalence of Stroke Risk Factors and Their Distribution Based on Stroke Subtypes in Gorgan: A Retrospective Hospital-Based Study - 2015-2016. *Neurology Research International*, *2018*. https://doi.org/10.1155/2018/2709654

Hamzei, F., Erath, G., Kücking, U., Weiller, C., & Rijntjes, M. (2020). Anatomy of brain lesions after stroke predicts effectiveness of mirror therapy. *European Journal of Neuroscience*, *52*(6), 3628–3641. https://doi.org/10.1111/ejn.14698

Harb, A., & Kishner, S. (2022). Modified Ashworth Scale. In StatPearls. StatPearls Publishing.

Jaafar, N., Che Daud, A. Z., Ahmad Roslan, N. F., & Mansor, W. (2021). Mirror Therapy Rehabilitation in Stroke: A Scoping Review of Upper Limb Recovery and Brain Activities. In *Rehabilitation Research and Practice* (Vol. 2021). Hindawi Limited. https://doi.org/10.1155/2021/9487319

Jose, N. (2014). Mirror Box Therapy. In *International Journal of Advances in Nursing Management* (Vol. 2, Issue 2). www.anvpublication.org

Karamat, S., Saeed, A., Khan, F. M., & Tariq, A. (2022). EFFECT OF MIRROR THERAPY VERSUS REPETITIVE FACILITATION EXERCISE ON UPPER LIMB FUNCTION IN POST STROKE

PATIENT. *The Rehabilitation Journal*, *06*(02), 351–356. https://doi.org/10.52567/trj.v6i02.128

Kim, H., & Shin, J.-H. (2022). Assessment of Upper Extremity Function in People With Stroke Based on the Framework of the ICF: A Narrative Review. *Brain & Neurorehabilitation*, *15*(2). https://doi.org/10.12786/bn.2022.15.e16

Kim, J.-H., & Lee, B. (2017). The Effect of Mirror Therapy on Functional Recovery of Upper Extremity after Stroke: A Randomized Pilot Study · Volume 10 · Original Research. In *J Exp Stroke Transl Med (www.jestm.com)* (Vol. 10). http://www.jestm.com

Kuriakose, D., & Xiao, Z. (2020). Pathophysiology and treatment of stroke: Present status and future perspectives. In *International Journal of Molecular Sciences* (Vol. 21, Issue 20, pp. 1–24). MDPI AG. https://doi.org/10.3390/ijms21207609

Li, R. C., Xu, W. D., Lei, Y. L., Bao, T., Yang, H. W., Huang, W. X., & Tang, H. R. (2019). The risk of stroke and associated risk factors in a health examination population: A cross-sectional study. *Medicine (United States)*, *98*(40). https://doi.org/10.1097/MD.0000000000017218

Lim, K. B., Lee, H. J., Yoo, J., Yun, H. J., & Hwang, H. J. (2016). Efficacy of mirror therapy containing functional tasks in poststroke patients. *Annals of Rehabilitation Medicine*, *40*(4), 629–636. https://doi.org/10.5535/arm.2016.40.4.629

Lin, K. C., Huang, P. C., Chen, Y. T., Wu, C. Y., & Huang, W. L. (2014). Combining afferent stimulation and mirror therapy for rehabilitating motor function, motor control, ambulation, and daily functions after stroke. *Neurorehabilitation and Neural Repair*, *28*(2), 153–162. https://doi.org/10.1177/1545968313508468

Luo, Z., Zhou, Y., He, H., Lin, S., Zhu, R., Liu, Z., Liu, J., Liu, X., Chen, S., Zou, J., & Zeng, Q. (2020). Synergistic effect of combined mirror therapy on upper extremity in patients with stroke: A systematic review and meta-analysis. *Frontiers in Neurology*, *11*. https://doi.org/10.3389/fneur.2020.00155

Mandeep, M., & Khurana, D. (2019). Reflections of mirror therapy on the functional recovery after stroke. Journal of the Neurological Sciences, 405, 97-98.

Manzoor, S., Umar, B., Niaz, M., Afzal, A., & Naz, M. (2021). *Effectiveness of Mirror Therapy on Upper Limb Function in patients with Stroke (Monoplegic)* (Vol. 15, Issue 1).

Michielsen, M. E., Selles, R. W., Van Der Geest, J. N., Eckhardt, M., Yavuzer, G., Stam, H. J., Smits, M., Ribbers, G. M., & Bussmann, J. B. J. (2011). Motor recovery and cortical reorganization after mirror therapy in chronic stroke patients: A phase II randomized controlled trial. *Neurorehabilitation and Neural Repair*, *25*(3), 223–233. https://doi.org/10.1177/1545968310385127

Mindova, S., & Karaganova, I. (2022). MIRROR THERAPY IN PHYSIOTHERAPEUTIC PRACTICE FOR RECOVERY OF THE MOTOR FUNCTION OF THE UPPER LIMB IN PATIENTS WITH ISCHEMIC STROKE. *Journal of IMAB - Annual Proceeding*

(Scientific Papers), *28*(2), 4330–4334. https://doi.org/10.5272/jimab.2022282.4330

Moon, K., Jang, W., Park, H. Y., Jung, M., & Kim, J. (2022). The Effects of Occupation-Based Community Rehabilitation for Improving Activities of Daily Living and Health-Related Quality of Life of People with Disabilities after Stroke Living at Home: A Single Subject Design. *Occupational Therapy International*, *2022*. https://doi.org/10.1155/2022/6657620

Nelakurthy, S., Baffireddy, S., Mahendra, R., Ch, V. D., Varshffinffi, H., & Ragamaffi, B. (2021). A Study on the Efficacy of Mirror Therapy in the Prognosis of Upper Extremity Motor functions in Stroke Patients. Oxidants and Antioxidants in Medical Science, 10(3), 6-12.

Pan, B., Huang, Z., Jin, T., Wu, J., Zhang, Z., & Shen, Y. (2021). Motor function assessment of upper limb in stroke patients. *Journal of Healthcare Engineering*, *2021*. https://doi.org/10.1155/2021/6621950

Paolucci, S., Antonucci, G., Troisi, E., Bragoni, M., Coiro, P., De Angelis, D., Pratesi, L., Venturiero, V., & Grasso, M. G. (2003). Aging and stroke rehabilitation: A case-comparison study. *Cerebrovascular Diseases*, *15*(1–2), 98–105. https://doi.org/10.1159/000067137

Park, J.-Y., Chang, M., Kim, M., & Kim, H.-J. (2015). *The effect of mirror therapy on upper-extremity function and activities of daily living in stroke patients*.

Park, Y., Chang, M., kiM, kYeong-M., & an, D. (2015). *The effects of mirror therapy with tasks on upper extremity function and self-care in stroke patients*.

Parmar, P. (2018). Stroke: classification and diagnosis. Clin. Pharm, 10(1).

Polit, D. F., & Beck, C. T. (2010). *Essentials of nursing research: Appraising evidence for nursing practice*. Lippincott Williams & Wilkins.

Prasetyaningsih, R. H., & Kurniawan, H. (2021). Application Of Mirror Therapy On Upper Extremity Motor Recovery In Post-Stroke Patients. *Jurnal Keterapian Fisik*, 136–144. https://doi.org/10.37341/jkf.v0i0.293

Sala, A., Anwer, S., Waris, A., Gilani, S. O., Iqbal, J., Shaikh, N., Pujari, A. N., & Khan Niazi, I. (2022). *healthcare Rehabilitation of Upper Limb Motor Impairment in Stroke: A Narrative Review on the Prevalence, Risk Factors, and Economic Statistics of Stroke and State of the Art Therapies*. https://doi.org/10.3390/healthcare

Shaker, H., Fahmy, E. M., Honin, A. A. N., & Mohamed, S. S. (2020). Effect of mirror therapy on hand functions in Egyptian chronic stroke patients. *Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, *56*(1). https://doi.org/10.1186/s41983-020-00226-8

Su, F., & Xu, W. (2020). Enhancing Brain Plasticity to Promote Stroke Recovery. In *Frontiers in Neurology* (Vol. 11). Frontiers Media S.A. https://doi.org/10.3389/fneur.2020.554089

Taub, E., Morris, D. M., Crago, J., King, D. K., Bowman, M., Bryson, C., Bishop, S., Pearson, S., & Shaw, S. E. (2011). *UAB Training for CI Therapy Wolf Motor Function Test (WMFT) Manual*.

Thieme, H., Morkisch, N., Mehrholz, J., Pohl, M., Behrens, J., Borgetto, B., & Dohle, C. (2018). Mirror therapy for improving motor function after stroke. In *Cochrane Database of Systematic Reviews* (Vol. 2018, Issue 7). John Wiley and Sons Ltd. https://doi.org/10.1002/14651858.CD008449.pub3

Veerbeek, J. M., Van Wegen, E., Van Peppen, R., Van Der Wees, P. J., Hendriks, E., Rietberg, M., & Kwakkel, G. (2014). What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. In *PLoS ONE* (Vol. 9, Issue 2). Public Library of Science. https://doi.org/10.1371/journal.pone.0087987

Waghavkar, S. N., & Ganvir, S. S. (2015). Effectiveness of Mirror Therapy to Improve Hand Functions in Acute and Subacute Stroke Patients. *International Journal of Neurorehabilitation*, *02*(04). https://doi.org/10.4172/2376-0281.1000184

Whitehead, S., & Baalbergen, E. (2019). Post-stroke rehabilitation. *South African Medical Journal*, *109*(2), 81–83. https://doi.org/10.7196/SAMJ.2019.v109i2.00011

Wu, C. Y., Huang, P. C., Chen, Y. T., Lin, K. C., & Yang, H. W. (2013). Effects of mirror therapy on motor and sensory recovery in chronic stroke: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation*, *94*(6), 1023–1030. https://doi.org/10.1016/j.apmr.2013.02.007

Yang, Y., Zhao, Q., Zhang, Y., Wu, Q., Jiang, X., & Cheng, G. (2018). Effect of Mirror Therapy on Recovery of Stroke Survivors: A

Systematic Review and Network Meta-analysis. *Neuroscience*, *390*, 318–336. https://doi.org/10.1016/j.neuroscience.2018.06.044

Yoon, J. A., Koo, B. Il, Shin, M. J., Shin, Y. B., Ko, H. Y., & Shin, Y. Il. (2014). Effect of constraint-induced movement therapy and mirror therapy for patients with subacute stroke. *Annals of Rehabilitation Medicine*, *38*(4), 458–466. https://doi.org/10.5535/arm.2014.38.4.458

Zeng, W., Guo, Y., Wu, G., Liu, X., & Fang, Q. (2018). Mirror therapy for motor function of the upper extremity in patients with stroke: A meta-analysis. In *Journal of Rehabilitation Medicine* (Vol. 50, Issue 1, pp. 8–15). Foundation for Rehabilitation Information. https://doi.org/10.2340/16501977-2287

Zhang, X., Zhang, Y., Liu, Y., & Yao, Q. (2021). Effectiveness of mirror therapy on upper limb function, activities of daily living, and depression in post-stroke depression patients. *Turkish Journal of Physical Medicine and Rehabilitation*, *67*(3), 365–369. https://doi.org/10.5606/tftrd.2021.6635

Appendices

Appendix 1: Study Approval

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Kingdom of Saudi Arabia Ministry of Education Majmaah University (47) Vice Rector for Graduate Studies & Scientific Research	جامعة المجمعة Majmaah University	المملكة العربية السعودية وزارة التعليم جامعة المجمعة (٤٧) وكالة الجامعة للدراسات العليا والبحث العلمي

To Whom It May Concern

The Majmaah University for Research Ethics committee (MUREC) (HA-01-R-088) has been reviewed the application referred to below and the ethical aspects approved.

Ethics Number: MUREC-Apr.13/COM-2022/32-5

Project Title: The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation.

Name of Researchers: Weam Okab Alsalem

Approval Date: 13/4/2022

Expiry Date: 13/4/2023

Conditions for approval:

1. The scientific evaluation of application form should be reviewed by pertaining party.
2. An approval from related parties must be obtained to be able to carry out the research method/tool on the target group.

As evidence of continuing compliance, the Research Ethics Committee requires that researchers immediately report:

(i) Proposed changes to the protocol including changes to investigators involved.
(ii) Serious or unexpected adverse effects on participants.
(iii) Unforeseen events that might affect continued ethical acceptability of the project.
(iv) Renew Ethical approval 30 days prior to the expiry date.
(v) You are also required to complete 2 monitoring reports after 6 months and at the end of your project. This report must be completed, signed by all researchers, and returned to the MUREC prior to the expiry date via Email IRB@mu.edu.sa

Note: Ethical approval should be obtained from The Minister of Health authorities and/or local hospitals prior to starting the research.

إلى من يهمه الأمر

استعرضت اللجنة المحلية لأخلاقيات البحوث بجامعة المجمعة (HA-01-R-088) مشروع البحث الموضح بياناته أدناه وتمت الموافقة عليه:

الرقم:MUREC-Apr.13/COM-2022/32-5

عنوان البحث: تأثيرالعلاج بالمرآة على الحركة الوظيفية للأطراف العلوية في تأهيل مرضى السكتة الدماغية.

أسماء الباحثين: وئام عقاب السالم

تاريخ الموافقة: ٢٠٢٢/٤/١٣

تاريخ الانتهاء: ٢٠٢٣/٤/١٣

شروط الموافقة:

١. يترك التقييم العلمي للاستبانة للجهة ذات الاختصاص.

٢. ضرورة الحصول على الموافقات الرسمية من الجهات ذات العلاقة لتوزيع الاستبانة على الفئة المستهدفة.

كدليل على الاستمرارية بجودة البحث يتطلب من الباحثين على الفور إشعار اللجنة في حالة:

(١) التغييرات المقترحة على المشروع بما في ذلك تغييرات على الفئة المستهدفة.
(٢) الآثار الخطيرة أو غير متوقعة على المشاركين.
(٣) الأحداث غير المتوقعة التي قد تؤثر على استمرار القبول الأخلاقي للمشروع.
(٤) تجديد الموافقة قبل انتهاء صلاحية الموافقة ب ٣٠ يوم.
(٥) كما يتعهد الباحثين بتسليم تقرير بعد ٦ أشهر وتقرير عند نهاية المشروع موقع من جميع الباحثين وإرساله إلى لجنة أخلاقيات البحوث بالكلية قبل تاريخ انتهاء صلاحية الموافقة على إيميل اللجنة IRB@mu.edu.sa

ملاحظة: يجب على الباحثين الحصول على الموافقة المحلية من وزارة الصحة للمستشفيات أو الجهات المعنية قبل البدء في البحث.

رئيس اللجنة المحلية لأخلاقيات البحوث بجامعة المجمعة

CHAIR OF MAJMAAH UNIVERSITY FOR RESEARCH ETHICS COMMITTEE

أ.د. أحمد بن علي الرميح

DR. AHMED BIN ALI ALROMAIH

جامعة المجمعة Majmaah University
اللجنة المحلية لأخلاقيات البحوث بجامعة المجمعة

الرقم : .... التاريخ : / / 144 هـ المشفوعات : ....

المملكة العربية السعودية – ص . ب: ٦٦ المجمعة ١١٩٥٢ – هاتف: ٠١٦٤٠٤١١٢٢ – فاكس : ٠١٦٤٠٤١١١٨

Kingdom of Saudi Arabia – P.O. Box: 66 Almajmaa 11952 - Tel: 016 404 1122 Fax : 016 404 1118
Email vrgs@mu.edu.sa www.mu.edu.sa

Appendix 2: IRB Approval from King Saud Medical City

Kingdom of Saudi Arabia
Ministry of Health
King Saud Medical City

مدينة الملك سعود الطبية
KING SAUD MEDICAL CITY

المملكة العربية السعودية
وزارة الصحة
مدينة الملك سعود الطبية

***IRB Registration Number with KACST, KSA*: H-01-R-053**
***IRB Registration Number U.S. Department of HHS IORG #*: IORG0010374**

- Memorandum -

Date: June 23, 2022

Proposal Reference No.	: H1RE-24-May22-02
Proposal Title	: "The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation"
PI	: Weam Okab Alsalem
Co-Investigators	: Abdulrahman Ibrahim Alduhaymi; Hassna Sharahili
Type of Review	: Initial
Category of Approval	: Expedited
Date of IRB Approval- Expiration (Validity)	: 23/06/2022 22/12/2022 (06months)

Dear Weam Okab Alsalem,

We are pleased to inform you that the above-referenced research proposal has been reviewed and was approved. The Institutional Review Board (IRB) committee found that the research met the applicability criteria and was eligible for expedited review. However, to commence the collection of data a permission letter must be issued from the Director of the Research Center first.

This approval is valid for **06 months** from the date of IRB review when approval is granted. The approval will no longer be in effect on the date listed above as the IRB expiration date. Please note that you are obligated to submit the following to IRB committee:

1. progress/final report on the 06 **months (08-Dec-2022)** (or earlier in the case the study has completed)
2. any manuscript resulting from this research for approval by IRB before submission to journals for publication.

The approval of the conduct of this proposal will be automatically suspended after 06 months, in the case the Progress Report (or Final Report, if relevant) is pending acceptance. You also need to notify the Research Centre as soon as possible in case of:

1. any amendments to the proposal;
2. termination of the study;
3. any serious or unexpected adverse events;
4. any event or new information that may affect the benefit/risk ratio of the proposal.

All records relating to the research including consent form must be retained and available for audit for at least 3 years after the research has ended.

We wish you every success in your research endeavors.

Dr. Faisal Almazroua
Chairman, Institutional Review Board (IRB)
King Saud Medical City Riyadh, KSA

وزارة الصحة المملكة العربية السعودية
مدينة الملك سعود الطبية
King Saud Medical City
لجنة أخلاقيات البحوث (IRB)

☎435-5555 Ext. 2345 irb@ksmc.med.sa

Appendix 3: IRB Approval from The General Directorate of Health Affairs in Aljouf Region

وزارة الصحة
Ministry of Health

Research Ethic Committee
Qurayyat Health Affairs
Registered with NCBE
Reg NO: H-13-S-071

To: **Mrs. Weam Okab Alsalem**
Physical Therapist
General Directorate of Health Affairs at Aljouf Region, Kingdom of Saudi Arabia
Email: woalsalem@moh.gov.sa
Principal Investigator

Cc: Khadijah Alfaleh
Co-Investigator

Subject: **IRB Approval of Research Project No. 2022-18**
Study Title: The Effect of Mirror Therapy on Upper Extremity Motor Function in stroke Rehabilitation in Saudi Arabia.

Date of Approval: 10Oct 2022
Date of Expiry: 10Feb 2023

Dear Mrs. Weam Okab Alsalem,

I am pleased to inform you that your above-mentioned research project submitted to the IRB was reviewed and approved. You are now granted permission to conduct this study as approved by the IRB. Please note that this approval is for the research ethics perspective only. You still need toat least notify the department head or unit to collect data.

As principal investigator, you are required to abide by the rules and regulations of the Kingdom of Saudi Arabia and the research policies and procedures of the NCBE IRB. If you make any changes to the protocol during the period of this approval, you must submit a revised protocol for IRB approval prior to implementing the changes. Please be advised that regulations require that you submit a progress report on your research every 6 months. You are also required to submit any manuscript resulting from this research for approval by IRB before submission to journals for publication.

As a researcher you are requested to have current and valid certification on protection human research subjects that can be obtained by taking a short online course at national committee of bioethics(NCBE) site followed by a multiple choice test. Please submit your current and valid certificate for our records.
Failure to submit this certificate shall a reason for suspension of your research project.

We wish you success in your research and request you to keep the IRB informed about the progress of the study on a regular basis by submitting a *Study Progress Report* annually and a Final Report when the study has been completed. Please quote the project number and project title above in any further correspondence related to this study.

Thank you!

Sultan Alghnimi
Chairman Of the Local Research Ethics Committee
Qurayyat Health Affairs
Email: Rsd-qurt@moh.gov.sa

www.moh.gov.sa | 937 | SaudiMOH | MOHPortal | SaudiMOH | Saudi_Moh

Appendix 4: IRB Approval from Prince Sultan Bin AbdulAziz Humanitarian City

مدينة سلطان بن عبد العزيز للخدمات الإنسانية
SULTAN BIN ABDULAZIZ HUMANITARIAN CITY

مدينة سلطان بن عبد العزيز للخدمات الإنسانية
SULTAN BIN ABDULAZIZ HUMANITARIAN CITY
لجنة أخلاقيات البحوث الطبية
Institutional Review Board (IRB)

Date: 01/12/2022
IRB No.: 84-2022-IRB

To: **Ms. Weam AlSalem**
MSc: "The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation."
AlMajmaah University
E-mail: Weam.Alsalem@hotmail.com

Subject: Approval for MSc Research No. 80/MSc/2022
Study Title: "The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation."
Study Code: 80/MSc/2022
Date of Approval: 01/12/2022
Date of Expiry: 1/10/2023
Board approval: Approved by the members

Dear **Ms. Weam AlSalem,**

Your Project has been approved and you have the permission to conduct this study following your submitted documents as follow:

1. Curriculum Vitae for the PI researcher
2. Letter from the researcher requesting SBAHC participation in the clinical study
3. Research proposal according to SBAHC IRB Guidelines
4. SBAHC Informed Consent Template
5. Research Obligatory Agreement. Available upon the completion of the other requirements

You are required to obey by the rules and regulations of the Government of Saudi Arabia, the SBAHC IRB Policies and procedures and the ICH-GCP guidelines. You have to note that this approval mandate responding to IRB's periodic request and surveillance result. Drawing your attention to the following:

- Amendment of the project with the required modification to providing Periodical report for this project specially when study extension is required or expiry before study completion

Page 1 of 2

- All unforeseen events that might affect continued ethical acceptability of the project should be reported to the IRB as soon as possible
- Any serious unexpected adverse events should be reported immediately within 24 hours.
- Personal identifying data should only be collected when necessary for research.
- Secondary disclosure of personal identifiable data is not allowed.
- Monitoring: projects may be subject to an audit by the IRB at any time.
- The PI is responsible for the storage and retention of original data pertaining to the project for a minimum period of five (5) years.
- Data should be stored securely so that a few authorized users are permitted access to the database.

The IRB registered with the IRB KACST Registration No. H-01-R-090. It is authorized to conduct the ethical review of clinic studies and operates in accordance with ICH-GCP Guidelines and all applicable national/local and institutional regulations and guidelines which govern Good Clinical Practices.

A final report should be provided upon completion of the study a long with a copy of thesis should be submitted to the research center for archiving purposes.

Wish you a success in your research project.

Yours sincerely,

Prof. Khalid Al-Rubeaan
Chairman-IRB
Sultan Bin Abdulaziz Humanitarian City

مدينة سلطان بن عبد العزيز للخدمات الإنسانية
SULTAN BIN ABDULAZIZ HUMANITARIAN CITY
لجنة أخلاقيات البحوث الطبية
Institutional Review Board (IRB)

Appendix 5: Consent Form for King Saud Medical City

King Saud Medical City **Research Center** **Generic Signed Consent Form**	**مدينة الملك سعود الطبية** **مركز الابحاث** **استمارة موافقة للمشاركة في بحث**

Computer Number			**رقم السجل**
Study Number			**رقم الدراسة**
Patient Name			**إسم المريض**
Date of Birth			**تاريخ الميلاد**
Gender (Male/Female)			**الجنس (ذكر | أنثى)**
Nationality			**الجنسية**

You are free to ask as many questions as you like before, during or after in this research, you decide to give consent to participate in this research study. The information in this form is only meant to better inform you all possible risks or benefits. Your participation in this study is voluntary. You do not have to take part in this study, and your refusal to participate will involve no penalty or loss of rights to which you are entitled. You may withdraw from this study at any time without penalty or loss of rights or other benefits to which you are entitled. The investigator(s) may stop your participation in this study without your consent for reasons such as: it will be in your best interest; you do not follow the study plan; or you experience a study-related injury.

كمشارك فى هذا البحث العلمى لك مطلق الحرية في طرح أى سؤال أو إستفسار عن هذا البحث وذلك قبل , أثناء إجراء, أو بعد إكمال إجراء البحث إذا قررت إعطاء الموافقة على المشاركة في هذا البحث. الهدف الرئيسى من المعلومات الواردة في هذا النموذج هو أن نقدم لكم الشرح الوافى والمستفيض عن كل الأخطار والفوائد التى يمكن أن تتمخض عن إجراء هذا البحث. المشاركة فى هذا البحث عمل طوعى خالص وبالتالى لكم مطلق الحرية بعدم المشاركة. قراركم بعدم المشاركة فى هذا البحث العلمى لا يترتب عليه اى تبعات او حرمان من حقوقكم المستحقة. أيضا يمكنكم الانسحاب وعدم مواصلة المشاركة فى هذا البحث فى أى وقت أو مرحلة دون أن يؤثر ذلك فى حقوقكم أو فوائدكم المستحقة والمشرعة. لأعضاء فريق البحث العلمى الخاص بهذه الدراسة الحق في إيقاف أو إلغاء مشاركتكم في هذه الدراسة إذا رأو مصلحة لكم فى هذا الإيقاف أو الإلغاء أو فى حالة عدم التزامكم بخطة البحث الموضوعة أو إذا تبين لهم ضرر أو إصابة نتيجة إجراء الدراسة وذلك دون أخذ موفقتكم

تأثير العلاج بالمرآة على الحركة الوظيفية للأطراف العلوية في تأهيل مرضى السكتة الدماغية.	**عنوان المشروع**
Project Title	The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation.
ونام عقاب السالم	**الباحث الرئيسي**
Principle investigator	Weam Okab Alsalem

KSMC-UNIT11 RESEARCH-GSCF-005 APPROVED DATE: 16/10/2016 Page 1

Appendix 6: Consent Form for Hospitals in Aljouf Region

وزارة الصحة
Ministry of Health

Consent Form for Minimal Risk

IRB Log Number:	H-13-S-071	H-13-S-071	رقم البحث العلمي:
Subject or Study Number:			اسم المشارك:
Medical Record Number:			رقم السجل الطبي:
Study Title E:	The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation.		
	تأثير العلاج بالمرآة على الحركة الوظيفية للأطراف العلوية في تأهيل مرضى السكتة الدماغية.		عنوان البحث العلمي بالعربي:
Principal Investigator:	Weam Okab Alsalem	وئام عقاب السالم	الباحث الرئيس:
Affiliation:	General Directorate of Health Affairs in Aljouf Region	المديرية العامة للشؤون الصحية بمنطقة الجوف	مكان العمل:
Telephone or Mobile No.:	0556190957	٠٥٥٦١٩٠٩٥٧	رقم الهاتف أو الجوال:

Why this study is being done?	**ما سبب القيام بهذا البحث العلمي؟**
This research is a required part of the master's thesis.	هذا البحث هو جزء متطلب للحصول على درجة الماجستير.

How many people will take part in this study? Sample size	**كم عدد الأشخاص المفترض مشاركتهم في هذا البحث العلمي؟ حجم عينة البحث**
38	٣٨

What are the objectives of the Study?	**ما هي أهداف هذا البحث العلمي؟**
1. To find out the effectiveness of conventional physical therapy treatment on improving upper extremity motor function among chronic hemiplegic patients. 2. To find out the effectiveness of mirror therapy along with conventional physical therapy treatment on improving upper extremity motor function among chronic hemiplegic patients. 3. To find out the effectiveness of mirror therapy along with conventional physical therapy treatment versus conventional physical therapy treatment on improving upper extremity motor function among chronic hemiplegic patients.	١- لمعرفة فعالية العلاج الطبيعي التقليدي في تحسين الوظيفة الحركية للطرف العلوي بين مرضى الشلل النصفي المزمن. ٢- لمعرفة فعالية العلاج بالمرآة إلى جانب العلاج الطبيعي التقليدي في تحسين الوظيفة الحركية للطرف العلوي بين مرضى الشلل النصفي المزمن. ٣- لمعرفة فعالية العلاج بالمرآة جنبًا إلى جنب مع العلاج الطبيعي التقليدي مقابل العلاج الطبيعي التقليدي في تحسين الوظيفة الحركية للطرف العلوي بين مرضى الشلل النصفي المزمن.

Appendix 7: Consent Form for Prince Sultan Bin AbdulAziz Humanitarian City

مدينة سلطان بن عبد العزيز للخدمات الإنسانية
SULTAN BIN ABDULAZIZ HUMANITARIAN CITY
RESEARCH & SCIENTIFIC CENTER

INFORMED CONSENT FOR RESEARCH INVOLVING THE ADMINISTRATION OF (DRUGS, USE OF DEVICES OR PERFORMANCE OF PROCEDURES) *

اذن ناف للجهالة بالموافقة على المشاركة في الأبحاث
التي تتطلب استعمال (دواء/جهاز/ أو إجراءات خاصة)*
(اشطب ما لا ينطبق)*

Patient's Nameplate:

Title of Proposal: The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation.	**عنوان البحث :** تأثير العلاج بالمرآة على الحركة الوظيفية للأطراف العلوية في تأهيل مرضى السكتة الدماغية.
Part I – Research Participant Information Sheet: You are invited to participate in a scientific research project	**الجزء الأول – معلومات للمشارك في البحث:** **ندعوك للمشاركة في بحث علمي**
A. Purpose of the Research is to increase general knowledge about	أ. **الغرض من البحث هو زيادة المعرفة عن**
To find out the effectiveness of MT in improving upper limb motor function in chronic hemiplegic subjects.	فعالية العلاج بالمرآة في تحسين الوظيفة الحركية للأطراف العلوية في الأشخاص المصابين بشلل نصفي مزمن.
B. Description of the Research:	ب. **وصف البحث:**
Mirror Therapy (MT) is one of the alternative therapies, based on the use of the interaction of visual proprioception inputs. The therapy commonly uses a mirror box in which the subjects' affected extremity will be kept in and the subject will visualize the normal extremity movement in the mirror while practicing the movements with the effected extremity which is inside the mirror box. This kind of mirror image will facilitate the mirror neurons in the affected side of the brain and stimulate the motor neurons connecting to the effected side extremity muscles thus resulting in the improvement of motor function. The combination of this physical and mental practice has claimed to improve motor function up to 80-95 percent among many stroke subjects **(Jose, 2014).** MT Therapy will involve reaching, grasping and dexterity movements of the unaffected upper extremity followed by the imitation in the affected upper extremity. Subjects will be asked to make five different movements: (a) pronation and supination of the forearm, (b) flexion	العلاج بالمرآة هو أحد العلاجات البديلة، يعتمد على استخدام تفاعل مدخلات الحس البصري. عادةً ما يستخدم العلاج صندوق مرآة يتم وضع الأطراف المصابة فيه محجوبًا وسيتصور المريض حركة الأطراف الطبيعية في المرآة أثناء ممارسة الحركات مع الطرف المصاب الموجود داخل صندوق المرآة. سيسهل هذا النوع من الصور المعكوسة في المرآة الخلايا العصبية المرآتية في الجانب المصاب من الدماغ ويحفز الخلايا العصبية الحركية التي تتصل بعضلات الأطراف الجانبية المتأثرة مما يؤدي إلى تحسين الوظيفة الحركية. وقد ادعى الجمع بين هذه الممارسة الجسدية والعقلية أنه يحسن الوظيفة الحركية بنسبة تصل إلى ٨٠-٩٥ في المائة بين العديد من الأشخاص المصابين بالسكتة الدماغية (خوسيه، ٢٠١٤). سيشمل العلاج حركات الوصول والإمساك والبراعة للأطراف العلوية غير المتأثرة يليها التقليد في الطرف العلوي المصاب. سيُطلب من الأشخاص القيام بخمس حركات مختلفة: (أ) لف واستلقاء الساعد، (ب) ثني المعصم وتمديده، (ج) ثني الأصابع وتمديدها، (د) الترقيم و (هـ) لمس طرف الإبهام لأطراف الأصابع على انفراد.

For Official Use Only
INFORMED CONSENT FOR RESEARCH INVOLVING THE ADMINISTRATION OF (DRUGS, USE OF DEVICES OR PERFORMANCE OF PROCEDURES) *
(Cross out the not applicable)*

From: ____________________
To ____________________
RAC# ____________________

إذن ناف للجهالة بالموافقة على المشاركة في الأبحاث
التي تتطلب استعمال (دواء/جهاز/ أو إجراءات خاصة)*
(اشطب ما لا ينطبق)*

مدينة سلطان بن عبد العزيز للخدمات الإنسانية
SULTAN BIN ABDULAZIZ HUMANITARIAN CITY
لجنة أخلاقيات البحوث الطبية
Institutional Review Board (IRB)

SBAHC 1803 – RSC.CS (11/21) ME
Informed Consent for Research Involving the Administration of (Drugs, Use of Devices or Performance of Procedures) *

Page | 1

Appendix 8: Mini Mental Status Examination

Creating Connections. Changing Lives. PAR®

Sent Via Email: 421203818@s.mu.edu.sa

April 19, 2022

Weam O. Alsalem
Majmaah University
4254 Alshulhoub ave, Sakaka, Saudi Arabia
Sakaka, Aljouf 72341
Saudi Arabia

Dear Weam Alsalem:

In response to your recent request, permission is hereby granted to you to reproduce up to a total of 38 copies of the Arabic version of the Mini-Mental State Examination-2 (MMSE-2) Standard Version Blue Form for use only in your research titled, *The Effect of Mirror Therapy on Upper Extremity Motor Function in Stroke Rehabilitation*. If additional copies are needed, it will be necessary to write to PAR for further permission.

This Agreement is subject to the following restrictions:

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(4) The Forms will not be stored on any local computer/server/ network, website/ share drive or portable device for access by any individual.

(5) An accurate count of the total number of administrations using the translation will be kept.

(6) Payment of a royalty fee of $60.00 USD. This fee includes a 40% student discount.

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TWO COPIES of this Permission Agreement should be signed and returned to me, along with your payment for **$60.00 USD** for the royalty fee, to indicate your agreement with the above restrictions. I will then sign it for PAR and return a fully executed copy to you for your records.

Sincerely,

Andrea Butler Fernandez
Jr. Permissions Specialist
afernandez@parinc.com
1-800-331-8378 (phone)
1-800-727-9329 (fax)

ACKNOWLEDGED, ACCEPTED AND AGREED:

By: [signature] Weam O. Alsalem

Date: 9-5-2022

By: Andrea Butler Fernandez

Andrea Butler Fernandez

Date: May 9, 2022

Payment Received: VISA
PAR Customer No.: CU-10011962

SIGNATURE OF PROFESSOR REQUIRED:

I hereby agree to supervise this student's use of these materials. I also certify that I am qualified to use and interpret the results of these tests as recommended in the *Standards for Educational and Psychological Testing*, and I assume full responsibility for the proper use of all materials used per this Agreement.

By:________________________________
Dr. Shaikh Abdulrahim

Creating Connections. Changing Lives. PAR

Appendix A

English MMSE-2 Sample Items

Orientation to Time
"What day is today? What is the .... Date? "

Naming
"What is this?" [Point to eye.]

Repetition
"Now I am going to ask you to repeat what I say. Ready? It is a lovely, sunny day but too warm. Now you say that. [Wait for examinee response and record response verbatim. Repeat up to one time.]

Arabic MMSE-2 Sample Items

توجهات الزمان
"ما هو اليوم الحالي؟ ما هو / هي ال ... تاريخ اليوم؟"

التسمية
ما هذا؟ (أشر إلى العين)

التكرار
.الآن سوف اسالك أن تكرر ما سوف أقول .جاهز؟ إنه يوم جميل ومشمس ولكن دافئ جداً .الآن كرر ذلك
.(إنتظر إجابة المفحوص وسجل الإجابة حرفيا .كرر مرة واحدة)

Appendix 9: Modified Ashworth Scale

Modified Ashworth Scale Testing Form

Name:____ Date:___________

Muscle Tested   Score

_________________ _____

_________________ _____

_________________ _____

_________________ _____

_________________ _____

_________________ _____

_________________ _____

_________________ _____

_________________ _____

Appendix 10: Fugl-Meyer Assessment Upper Extremity

Rehabilitation Medicine, University of Gothenburg

FUGL-MEYER ASSESSMENT
UPPER EXTREMITY (FMA-UE)
Assessment of sensorimotor function

ID:
Date:
Examiner:

Fugl-Meyer AR, Jaasko L, Leyman I, Olsson S, Steglind S: The post-stroke hemiplegic patient. A method for evaluation of physical performance. Scand J Rehabil Med 1975, 7:13-31.

A. UPPER EXTREMITY, sitting position

I. Reflex activity		none	can be elicited
Flexors: biceps and finger flexors		0	2
Extensors: triceps		0	2
	Subtotal I (max 4)		

II. Volitional movement within synergies, without gravitational help			none	partial	full
Flexor synergy: Hand from contralateral knee to ipsilateral ear. From extensor synergy (shoulder adduction/ internal rotation, elbow extension, forearm pronation) to flexor synergy (shoulder abduction/ external rotation, elbow flexion, forearm supination).	Shoulder	retraction	0	1	2
		elevation	0	1	2
		abduction (90°)	0	1	2
		external rotation	0	1	2
	Elbow	flexion	0	1	2
	Forearm	supination	0	1	2
Extensor synergy: Hand from ipsilateral ear to the contralateral knee	Shoulder	adduction/internal rotation	0	1	2
	Elbow	extension	0	1	2
	Forearm	pronation	0	1	2
		Subtotal II (max 18)			

III. Volitional movement mixing synergies, without compensation		none	partial	full
Hand to lumbar spine	cannot be performed, hand in front of SIAS	0		
	hand behind of SIAS (without compensation)		1	
	hand to lumbar spine (without compensation)			2
Shoulder flexion 0°-90°	immediate abduction or elbow flexion	0		
elbow at 0°	abduction or elbow flexion during movement		1	
pronation-supination 0°	complete flexion 90°, maintains 0° in elbow			2
Pronation-supination	no pronation/supination, starting position impossible	0		
elbow at 90°	limited pronation/supination, maintains position		1	
shoulder at 0°	complete pronation/supination, maintains position			2
	Subtotal III (max 6)			

IV. Volitional movement with little or no synergy		none	partial	full
Shoulder abduction 0 - 90°	immediate supination or elbow flexion	0		
elbow at 0°	supination or elbow flexion during movement		1	
forearm pronated	abduction 90°, maintains extension and pronation			2
Shoulder flexion 90°- 180°	immediate abduction or elbow flexion	0		
elbow at 0°	abduction or elbow flexion during movement		1	
pronation-supination 0°	complete flexion, maintains 0° in elbow			2
Pronation/supination	no pronation/supination, starting position impossible	0		
elbow at 0°	limited pronation/supination, maintains extension		1	
shoulder at 30°-90° flexion	full pronation/supination, maintains elbow extension			2
	Subtotal IV (max 6)			

V. Normal reflex activity evaluated only if full score of 6 points achieved on part IV				
biceps, triceps,	0 points on part IV or 2 of 3 reflexes markedly hyperactive	0		
finger flexors	1 reflex markedly hyperactive or at least 2 reflexes lively		1	
	maximum of 1 reflex lively, none hyperactive			2
	Subtotal V (max 2)			
	Total A (max 36)			

B. WRIST support may be provided at the elbow to take or hold the position, no support at wrist, check the passive range of motion prior testing		none	partial	full
Stability at 15° dorsiflexion elbow at 90°, forearm pronated shoulder at 0°	less than 15° active dorsiflexion dorsiflexion 15°, no resistance is taken maintains position against resistance	0	1	2
Repeated dorsifexion / volar flexion elbow at 90°, forearm pronated shoulder at 0°, slight finger flexion	cannot perform volitionally limited active range of motion full active range of motion, smoothly	0	1	2
Stability at 15° dorsiflexion elbow at 0°, forearm pronated slight shoulder flexion/abduction	less than 15° active dorsiflexion dorsiflexion 15°, no resistance is taken maintains position against resistance	0	1	2
Repeated dorsifexion / volar flexion elbow at 0°, forearm pronated slight shoulder flexion/abduction	cannot perform volitionally limited active range of motion full active range of motion, smoothly	0	1	2
Circumduction	cannot perform volitionally jerky movement or incomplete complete and smooth circumduction	0	1	2
	Total B (max 10)			

C. HAND support may be provided at the elbow to keep 90° flexion, no support at the wrist, compare with unaffected hand, the objects are interposed, active grasp		none	partial	full
Mass flexion from full active or passive extension		0	1	2
Mass extension from full active or passive flexion		0	1	2
GRASP				
A – flexion in PIP and DIP (digits II-V) **extension in MCP II-V**	cannot be performed can hold position but weak maintains position against resistance	0	1	2
B – thumb adduction 1-st CMC, MCP, IP at 0°, scrap of paper between thumb and 2-nd MCP joint	cannot be performed can hold paper but not against tug can hold paper against a tug	0	1	2
C - opposition pulpa of the thumb against the pulpa of 2-nd finger, pencil, tug upward	cannot be performed can hold pencil but not against tug can hold pencil against a tug	0	1	2
D – cylinder grip cylinder shaped object (small can) tug upward, opposition in digits I and II	cannot be performed can hold cylinder but not against tug can hold cylinder against a tug	0	1	2
E – spherical grip fingers in abduction/flexion, thumb opposed, tennis ball	cannot be performed can hold ball but not against tug can hold ball against a tug	0	1	2
	Total C (max 14)			

D. COORDINATION/SPEED after one trial with both arms, blind-folded, tip of the index finger from knee to nose, 5 times as fast as possible		marked	slight	none
Tremor		0	1	2
Dysmetria	pronounced or unsystematic slight and systematic no dysmetria	0	1	2
		> 5s	2 - 5s	< 1s
Time	more than 5 seconds slower than unaffected side 2-5 seconds slower than unaffected side maximum difference of1 second between sides	0	1	2
	Total D (max 6)			

TOTAL A-D (max 66)	

Approved by Fugl-Meyer AR 2010 2

H. SENSATION, upper extremity blind-folded, compared with unaffected side		**anesthesia**	**hypoesthesia dysesthesia**	**normal**
Light touch	upper arm, forearm	0	1	2
	palmar surface of the hand	0	1	2
		absence less than 3/4 correct	**3/4 correct considerable difference**	**correct 100% little or no difference**
Position small alterations in the position	shoulder	0	1	2
	elbow	0	1	2
	wrist	0	1	2
	thumb (IP-joint)	0	1	2
			Total H (max12)	

J. PASSIVE JOINT MOTION, upper extremity				**J. JOINT PAIN** during passive motion, upper extremity		
Sitting position, compare with unaffected side	only few degrees (less than 10° in shoulder)	decreased	normal	pronounced constant pain during or at the end of movement	some pain	no pain
Shoulder						
Flexion (0° - 180°)	0	1	2	0	1	2
Abduction (0°-90°)	0	1	2	0	1	2
External rotation	0	1	2	0	1	2
Internal rotation	0	1	2	0	1	2
Elbow						
Flexion	0	1	2	0	1	2
Extension	0	1	2	0	1	2
Forearm						
Pronation	0	1	2	0	1	2
Supination	0	1	2	0	1	2
Wrist						
Flexion	0	1	2	0	1	2
Extension	0	1	2	0	1	2
Fingers						
Flexion	0	1	2	0	1	2
Extension	0	1	2	0	1	2
Total (max 24)				**Total** (max 24)		

A. UPPER EXTREMITY	/36
B. WRIST	/10
C. HAND	/14
D. COORDINATION / SPEED	/ 6
TOTAL A-D (motor function)	/66

H. SENSATION	/12
J. PASSIVE JOINT MOTION	/24
J. JOINT PAIN	/24

Appendix 11: Wolf Motor Function Test

UAB Training for CI Therapy

WOLF MOTOR FUNCTION TEST
DATA COLLECTION FORM

Subject's Name: ______________________________________ Date: ____________________

Test (check one): Pre-treatment _____ Post-treatment _____ Follow-up ____

Arm tested (check one): More-affected ______ Less-affected _____

Task	Time	Functional Ability	Comment
1. Forearm to table (side)		0 1 2 3 4 5	
2. Forearm to box (side)		0 1 2 3 4 5	
3. Extend elbow (side)		0 1 2 3 4 5	
4. Extend elbow (weight)		0 1 2 3 4 5	
5. Hand to table (front)		0 1 2 3 4 5	
6. Hand to box (front)		0 1 2 3 4 5	
7. Weight to box	______________	______________lbs.	
8. Reach and retrieve		0 1 2 3 4 5	
9. Lift can		0 1 2 3 4 5	
10. Lift pencil		0 1 2 3 4 5	
11. Lift paper clip		0 1 2 3 4 5	
12. Stack checkers		0 1 2 3 4 5	
13. Flip cards		0 1 2 3 4 5	
14. Grip strength	______________	______________kgs.	
15. Turn key in lock		0 1 2 3 4 5	
16. Fold towel		0 1 2 3 4 5	
17. Lift basket		0 1 2 3 4 5	

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Appendix 12: Data Collection Sheet

Demographic Data

1- Age:

☐ 45-50 years ………… ☐ 51-55 years …………

☐ 56-60 years ………… ☐ 61-65 years …………

2- Gender:

☐ Male ☐ Female

3- Hypertensive?

☐ Yes ☐ No

4- Diabetic?

☐ Yes ☐ No

5- Which side is affected by the stroke?

☐ Right ☐ Left ☐ Both

6- Type of stroke:

☐ Hemorrhagic ☐ Ischemic

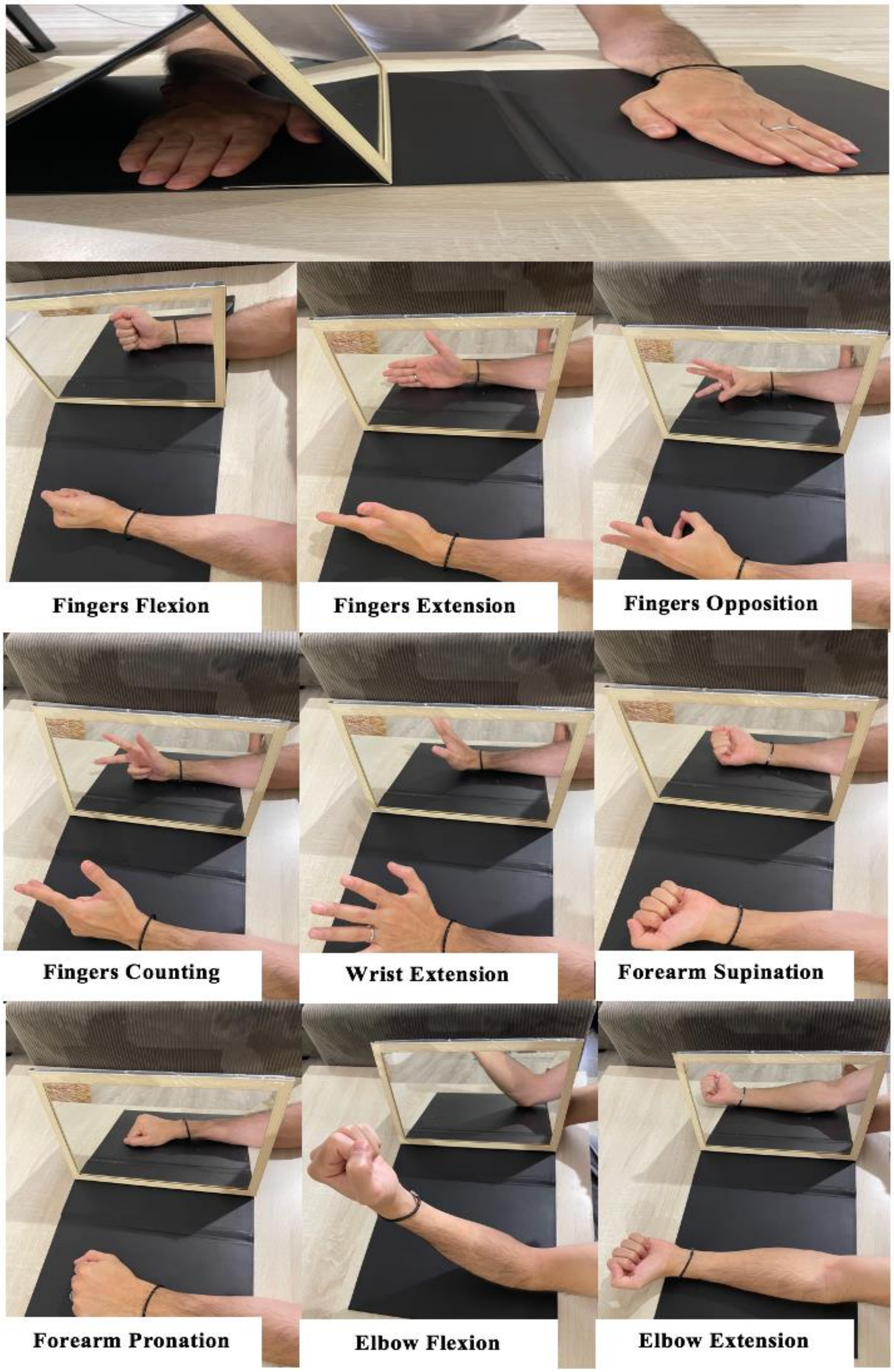
7- Height (cm): ………… **8- Weight (kg):** …………

9- Stroke onset time (months): …………

10-Smoker?

☐ Yes ☐ No

Appendix 13: Demonstration of the five activities of MT Program



Appendix 14: Comparison of current study WMFT-FA and FMA-UE scores with three previous studies' findings.

S. No	Author name and Year	Group	Pre WMFT-FA (Mean ± SD)	Post WMFT-FA (Mean ± SD)	Pre FMA-UE (Mean ± SD)	Post FMA-UE (Mean ± SD)
1	Current study by (Alsalem et al., 2023)	Experimental	34.26 ± 13.40	54.74 ± 17.36	80.84 ± 24.12	99.63 ± 22.78
		Control	40.16 ± 21.27	42.58 ± 21.16	85.84 ± 27.39	89.42 ± 26.62
2	(Waghavkar & Ganvir, 2015)	Experimental	7.5 ± 1.8	15.7 ± 2.4	34.18 ± 8.38	47.36 ± 2.54
3	(Bai et al., 2019) (MMT)	Experimental	29.08 ± 7.38	37.25 ± 10.91	34.25 ± 12.21	44.42 ± 12.89
		Control	26.09 ± 9.72	30.82 ± 12.71	35.36 ± 10.62	39.73 ± 11.79
4	(Bai et al., 2019) (TMT)	Experimental	34.55 ± 9.54	44.55 ± 14.17	37.55 ± 14.19	42.82 ± 13.48
		Control	26.09 ± 9.72	30.82 ± 12.71	35.36 ± 10.62	39.73 ± 11.79
5	(Yoon et al., 2014)	Experimental	33.75 ± 22.51	51.50 ± 18.25	49.25 ± 25.21	70.13 ± 25.80
		Control	29.56 ± 27.43	28.73 ± 26.71	46.11 ± 26.81	55.56 ± 32.92

Appendix 15: Comparison of current study FMA-UE scores with eight previous studies' findings.

S. No	Author name and Year	Group	Pre FMA-UE (Mean ± SD)	Post FMA-UE (Mean ± SD)
1	(Manzoor et al., 2021)	Experimental	10.00 ± 9.07	60.13 ± 3.27
		Control	8.75 ± 14.49	29.2 ± 5.75
2	(Prasetyaningsih & Kurniawan, 2021)	Experimental	48.07 ± 13.05	42.93 ± 12.21
3	(Nelakurthy et al., 2021)	Experimental	29.27 ± 12.56	41.54 ± 9.96
		Control	26.72 ± 11.30	32.72 ± 9.72
4	(Zhang et al., 2021)	Experimental	16.8 ± 5.0	26.3 ± 6.4
		Control	15.6 ± 3.9	20.0 ± 5.1
5	(Pan et al., 2021)	Experimental	44.0 ± 11.85	51.0 ± 12.01
		Control	39.9 ± 12.6	42.7 ± 11.9
6	(Lin et al., 2014)	Experimental	44.21 ± 10.69	49.86 ± 8.97
		Control	43.80 ±10.68	47.13 ± 10.12
7	(Michielsen et al., 2011)	Experimental	39.7 ± 14.1	43.5 ± 14.0
		Control	36.4 ± 14.7	36.6 ± 14.2
8	(Wu et al., 2013)	Experimental	45.94 ± 8.91	51.25 ± 8.14
		Control	44.41 ± 10.69	47.88 ± 9.75
9	Current study by (Alsalem et al., 2023)	Experimental	80.84 ± 24.12	99.63 ± 22.78
		Control	85.84 ± 27.39	89.42 ± 26.62

المستخلص

الخلفية: تشكل السكتة الدماغية خطرًا بالغًا على التروية الدماغية ويعاني ١٥ مليون شخص في العالم من السكتة الدماغية سنويًا، والمشكلة الأكثر شيوعًا بعد السكتة الدماغية هي ضعف أو شلل جانب واحد من الجسم والذي يعطل أنشطة الحياة اليومية (ADL). ويعد العلاج بالمرآة (MT) أحد العلاجات البديلة التي تعتمد على تفاعل مدخلات الحس البصري العميق. **الهدف:** هدفت الدراسة إلى تحديد فعالية العلاج بالمرآة مقابل العلاج الطبيعي التقليدي في تحسين ضعف الأطراف العلوية والوظيفة الحركية بين الأشخاص المصابين بالشلل النصفي الطولي. **العينة والطريقة:** أُجريت هذه التجربة المنضبطة المعشّاه على ٣٨ شخصًا مصابًا بشلل نصفي طولي مزمن، وتم تخصيص العينة للمجموعات القياسية أو التجريبية بشكل عشوائي، حيث تتكون كلتا المجموعتين من ١٩ شخص. وقد تلقت المجموعة القياسية علاجًا فيزيائيًا تقليديًا (CPT)، بينما تلقت المجموعة التجريبية علاجًا بالمرآة إضافة إلى العلاج الفيزيائي التقليدي. كانت مدة العلاج ٤٥ دقيقة لكل جلسة، بمعدل ثلاث جلسات في الأسبوع، ولمدة ستة أسابيع. استخدم للتقييم الأولي اختبار الحالة العقلية المصغر (MMSE) ومقياس أشوورث المعدل (MAS). وتم تقييم ما قبل التدخل العلاجي وبعده لضعف الأطراف العلوية والوظيفة الحركية باستخدام تقييم Fugl-Meyer للطرف العلوي (FMA-UE) واختبار وولف لتقييم الحركة الوظيفية (WMFT) والذي يشمل نتائج كلا من الوقت والقدرة الوظيفية. **النتائج:** اشتملت العينة على ٣٨ شخصًا منهم ٢٦ ذكر و١٢ أنثى بمتوسط عمر ٥٤.٩٧ عامًا. ومن بين هؤلاء ٢٨ منهم مصاب بالسكتة الدماغية الإقفارية و١٠ المتبقية يعانون من السكتة الدماغية النزفية. عند وعند مقارنة النتائج بما قبل التدخل العلاجي وبعده، تحسنت المجموعات التجريبية والقياسية بشكل ملحوظ حيث كانت قيمة p < ٠.٠١ في جميع النتائج الثلاثة. وعندما قارنا التحسن في المجموعة التجريبية بالمجموعة القياسية، لوحظ لدى المجموعة التجريبية فرق ذو دلالة إحصائية مع قيمة p أقل من ٠.٠١ في جميع النتائج الثلاثة، أي (FMA-UE) وَ (WMFT) لكلًا من الوقت والقدرة الوظيفية. **الخلاصة:** اتضح أن العلاج بالمرآة إضافةً إلى العلاج الطبيعي التقليدي خلال ستة أسابيع والاي شملت ١٨ جلسة بمعدل ثلاث جلسات لمدة ٤٥ دقيقة لكل جلسة بأن لها الدور في تحسن المجموعة التجريبية بشكل فائق مقارنة بجلسات العلاج الطبيعي التقليدية وحدها في المجموعة القياسية. درجات التقييم لحالات الضعف والتي تم تقييمها بواسطة مقياس FMA-UE والوظيفة الحركية التي تم تقييمها بواسطة مقياس WMFT متضمنًا الوقت والقدرة الوظيفية كانت أعلى بشكل ملحوظ في المجموعة التجريبية عن المجموعة القياسية بقيمة p < ٠.٠٥.

الكلمات الرئيسية:

السكتة الدماغية، الشلل النصفي الطولي، العلاج بالمرآة، الحركة الوظيفية.

المملكة العربية السعودية

وزارة التعليم

جامعة المجمعة

عمادة الدراسات العليا

كلية العلوم الطبية التطبيقية

قسم العلاج الطبيعي والتأهيل الصحي

تأثير العلاج بالمرآة على الحركة الوظيفية للأطراف العلوية في تأهيل مرضى السكتة الدماغية.

رسالة مقدمة إلى كلية العلوم الطبية التطبيقية – جامعة المجمعة كجزء من متطلبات الحصول على درجة الماجستير في علوم العلاج الطبيعي

إعداد:

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٤٢١٢٠٣٨١٨

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١٤٤٤هـ – ٢٠٢٣ م