Faculty of Medicine

University of Dhaka

Evidence-based Physiotherapy Treatment for Improving Motor Function of Upper Limb for Stroke Survivors- A Systematic Review

By

Md. Ershad Ali

Master of Science in Physiotherapy (M. Sc. PT)

DU Roll No: 701

Registration No: 5247

Session: 2020 – 2021

BHPI, CRP, Savar, Dhaka-1343

Bangladesh Health Professions Institute (BHPI)
Department of Physiotherapy
CRP, Savar, Dhaka -1343 Bangladesh

May -2023

We the undersigned certify that we have carefully read and recommended to the Faculty of Medicine, University of Dhaka, for acceptance of this thesis entitled, " **Evidence-based Physiotherapy Treatment for Improving Motor Function of Upper Limb for Stroke Survivors- A Systematic Review**", submitted by **Md. Ershad Ali**, for the partial fulfillment of the requirements for the degree of Master of science in Physiotherapy.

E. Rahman
……………………..

Ehsanur Rahman
Assistant Professor
Department of Physiotherapy & Rehabilitation
JUST, Jashore-7408
Supervisor

……………………..

Professor Md. Obaidul Haque
Vice-Principal
BHPI, CRP, Savar, Dhaka-1343

……………………..

Dr. Kamal Ahmed
Associate Professor (Epidemiology)
IHT, Mohakhali, Dhaka

……………………..

Fabiha Alam
Assistant Professor
Department of Physiotherapy
BHPI, CRP, Savar, Dhaka-1343

Date of approval: 10th June, 2023

Declaration

- This work has not previously been accepted in substances for any degree and is not concurrently submitted in candidature for any degree.
- This dissertation is being submitted in partial fulfillment of the requirements for the degree of M.Sc. in physiotherapy.
- This dissertation is the result of my own independent work/investigation, except where otherwise stated. Other sources are acknowledged by giving explicit references. A Bibliography is appended.
- I confirm that if anything identified in my work that I have done plagiarism or any form of cheating that will directly awarded me fail and I am subject to disciplinary actions of authority.
- I confirm that the electronic copy is identical to the bound copy of the thesis.
- In case dissemination the finding of this project for future publication, research supervisor will highly concern and it will be a duly acknowledge as a graduate thesis.

Signature…………………………………………………………………………………..

Name………………………………………………………………………………………

Date……………………………………………………………………………………….

ACKNOWLEDGEMENT

I am immensely grateful to my supervisor, Ehsanur Rahman, Assistant Professor of Johore University of Science and Technology (JUST), for the guidance, cordial cooperation, support and encouragement during the entire period of the study. I would like to express my deepest gratitude to the Bangladesh Health Profession Institute (BHPI) for giving me the opportunity to perform this study.

I would like to thank my honorable teacher Professor Md. Obaidul Haque, Vice-Principal, BHPI for his cordial guidance. Special thanks to Md. Shofiqul Islam, Associate professor & Head, Department of Physiotherapy, BHPI, CRP and other board members for their support and guidance. I also pay my thanks to Md. Abid Hasan khan & Saiba Muhammad Sabrin, Intern Physiotherapist and Mahdi Ul Bari, Arnob Datta, Khadija Islam, Safa Tun Noor and Eshrat Jahan Eshaba, for helping me at the data screening section. I would pay to special gratitude to the Md. Arif Billah, Statistical officer of ICDDR, B and Lisa A. Hervey, Professor, University of Sydney for the guidance on systematic process and software management.

I would like to express my gratitude to the author, who have published their article and provided the information, related to my study and helped me to make my work successful.

CONTENTS

Topic	**Page no**
Acknowledgment	i
Acronyms	ii
List of tables	iii
Abstract	iv
CHAPTER- I: INTRODUCTION	1-12
1.1 Background	1-09
1.2 Rationale	10
1.3 Aim of the study 1.4 Objectives	11 12
CHAPTER- II: LITERATURE REVIEW	13-25
CHAPTER- III: METHODOLOGY	26-29
CHAPTER- IV: RESULTS	30-51
CHAPTER- V: DISCUSSION	52-54
CHAPTER- VI: REFERENCES	55-67
CHAPTER- VII: ANNEXURE (1, 2 & 3)	68-78
CHAPTER -VIII: SUPPLEMENTARY FILE	76-97

ACRONYMS

ADL	Activities of Daily Living
BHPI	Bangladesh Health Professions Institute
CIMT	Constraint-Induced Movement Therapy
CNS	Central Nervous System
CRP	Centre for the Rehabilitation of the Paralysed
DU	University of Dhaka
FMV	Focal Muscle Vibration
HS	Hemorrhagic Stroke
IS	Ischemic Stroke
LMICs	Low- and Middle-Income Countries
PNF	Proprioceptive Neuromuscular Facilitation
PRSMA	Preferred Reporting for Systematic Review and Meta-Analysis
QoL	Quality of Life
SSEP	Somato Sensory Evoked Potential
UL	Upper-Limb
WHO	World Health Organization

LIST OF TABLES

SI No	Topics	Page no
Table 01:	The PICO format	27
Table 02:	PRISMA flow chart	28
Table 03:	Exercise Therapy for improvement of upper limb motor function of stroke survivors	33-35
Table 04:	Manual therapy for improvement of upper limb motor function of stroke survivors	36-38
Table 05:	Electrotherapy for improvement of upper limb motor function of stroke survivors	38-43
Table 06:	Virtual reality, Gamming or Robotic therapy for improvement of upper limb motor function of stroke survivors	44-49
Table 07:	Combination of multiple therapeutic intervention for improvement of upper limb motor function of stroke survivors	50
Table 08:	Home exercise for improvement of upper limb motor function of stroke survivors	51

ABSTRACT

Background: Stroke, the second cause of mortality and the third cause of long-term disability worldwide. Mortality is declining, yet prevalence is stable that mean there are more survivors with long-term disability after stroke. Although the recovery stroke patients at an early stage depends on acute stroke care but their functional recovery and long-term health status are more affected by rehabilitation at different stages. One of the key disciplines in stroke rehabilitation is physical therapy which aimed at restoring and maintaining physical and physiological well-being of an individual.

Purpose: To review most recommended physiotherapy intervention by measuring their effectiveness on motor function recovery of upper limb for the stroke patients.

Method: Systematic review on stroke survivors with PEDro, Pub Med, Web of Science, Scopus Index, Cochrane library search engine (Time range January, 2012- December, 2022) followed by keywords in PICO format, Boolean operators & MeSH descriptors.

Result: The author identified 8212 articles as possibly relevant during the initial searches of all selected sources. After removing the duplicate & ensuring all screening process finally identified 91 articles for inclusion within time range. Overall, the review demonstrated that the different evidence of benefit of Exercise therapy, Manual therapy, Electrotherapy, Virtual reality, Gamming or Robotic Therapy, Combination of multiple exercise and home exercise for improvement of upper limb motor function of stroke survivors

Conclusion: However, the overall results showed that physical therapy-based rehabilitation training during the recovery period of stroke patients improves upper limb motor activity by reducing limb pain, increasing muscle strength that ultimately improve the quality of life. Majority of the finding supported that the interventions at different doses are more effective rather than the conventional only.

Key words*: Stroke survivors, Upper limb, physiotherapy, Motor recovery*

Word count:

CHAPTER-I	INTRODUCTION

1.1 : Background

Stroke is one of the leading causes of neurological disability worldwide, affecting an estimated 13 million people year (Saini et al., 2021). Stroke affects almost 15 million people annually around the globe (Valles et al., 2016), as reported by the World Health Organization. When a brain artery bursts or the blood supply to the brain is cut off, the result is a cerebrovascular accident. Stroke is a leading cause of mortality around the world, with more than two-thirds of all stroke deaths occurring in low- and middle-income regions (Feigin et al., 2009 & Addo et al., 2012). It ranks as the fifth leading cause of mortality for those between the ages of 15 and 59, and as the third leading cause of death for those aged 60 and up. By the year 2030, cerebrovascular illness is projected to overtake all other causes of death in low- and middle-income nations (Bustamante et al., 2016).

The European Stroke Council agrees with the findings of the Helsingborg Declaration that stroke is a leading cause of disability. While stroke was the second leading cause of death and disability globally in 2019, Over the past few decades, it has been rising far more quickly in low- and Middle-Income Countries (LMICs) than in High-Income Countries (HICs) (Krishnamurthi, Ikeda & Feigin, 2020; Johnson et al., 2019). Bangladesh's population and economy have changed dramatically during the past few decades. Bangladesh is now classified as a lower-middle-income country, and it is projected to advance to middle-income status by 2026 (Saha et al., 2018). Over a period of 30 years, the stroke incidence in low and middle-income countries (LMICs) in Bangladesh rose from 56 per 100,000 people to 117. Hypertension, dyslipidemia, cigarette use, diabetes, and ischemic heart disease were the most prevalent risk factors seen among stroke patients in Bangladesh (Mondal, Hasan, Khan& Mohammad, 2022). More than three-quarters of stroke patients in Bangladesh experienced an ischemic stroke.

Stroke incidence rates increased by 70% (67.0% to 73%), prevalence rates climbed by 85% (83.0% to 88.0%), and mortality rates increased by 43% between 1990 and 2019, according to the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD, 2019). (Feigin et al., 2022). Stroke has a significant global impact; in 2016, it was responsible for 42.2% of the disability-adjusted life-years (GBD, 2019), despite a declining mortality and prevalence rate. The incidence of strokes has increased over time in many Southeast Asian countries, India included. Stroke had a crude annual incidence of 108-172/100,000, a crude prevalence of 26-757/100,000, and a death rate of 18-42% in the first month after a case, according to an epidemiological study in India (Jones et al., 2022). In 2017, there were 1.12 million new stroke cases, 9.53 million stroke survivors, 0.46 million stroke-related deaths, and 7.06 million disability-adjusted life years lost in the European Union. With an aging population and an increase in life expectancy, the number of European Union residents who survive a stroke is projected to rise by 27% between 2017 and 2047 (Wafa, Wolfe, Emmet, Roth & Wang, 2020).

The degree of damage to the target areas of the brain affects the range of symptoms reported after a stroke. More than 8% of people who have had a stroke have motor impairment that affects both their upper and lower extremities (Divya & Narkeesh, 2022). Only a few of the challenges that stroke survivors may experience include hemiparesis, motor deficits, cognitive deficits, aphasia, proprioceptive deficits, and depressive symptoms (Gresham, Stason& Duncan, 2004; Semrau, Herter, Scott & Dukelow, 2013). The most typical after-stroke signs and symptoms are hemiparesis (Gracies et al., 2019) and muscle weakness (Schinwelski, Sitek & Sawek, 2019).

Both of these illnesses are characterized by a loss of function on one side of the body. According to Faria-Fortini, Michaelsen, Cassiano, and Teixeira-Salmela (2011), dystonia, active range of motion deficits, and impairments in movement speed, precision, and bimanual coordination are all important contributors to functional disability and ADLs. For stroke victims, spasticity-induced paralysis is a significant problem (Chuang, Wu, & Lin, 2012). In the clinic, resistance to passive range of motion is a sign of spasticity, which is defined by abnormally high muscle tone (Bhakta, 2000). Spasticity, a velocity-dependent motor disorder, is characterized by an augmented tonic stretch reflex due to hyperexcitability of the stretch reflex. Ineffective management of spasticity can lead to muscle and tendon shortening as well as joint stiffness. This could seriously impair one's ability to carry out daily chores (Seim, Wolf & Starner, 2021). Participants also reported significant muscle weakening in the trunk's main muscles (Van Criekinge et al., 2017), which affects balance and coordination while sitting.

Prognosis in stroke patients is heavily influenced by the severity of neurological abnormalities and complications they experience after the initial event (Kuzu, Adiguzel, Kesikburun, Yaşar & Ylmaz, 2021). The effectiveness of the patient's upper and lower extremities, as well as their trunk, typically decreases during the acute phase of stroke (French et al., 2010). The majority of stroke patients are unable to use their upper extremities in ADL after months of taking rehabilitation services (Thrasher, Zivanovic, Mcilroy & Popovic, 2008), despite the fact that many stroke patients are able to recover some walking function during initial rehabilitation. About half of those affected have difficulty using their upper limbs, and another 35-55% have impaired tactile perception (Seim, Wolf & Starner, 2021). An estimated 55 percent of stroke survivors have a nonfunctional upper extremity after initial therapy; another 30 percent have had some partial recovery of upper extremity function in terms of range of motion and strength but still are unable to perform ADLs with the affected upper extremity, negatively impacting independence and increasing the burden of care (Thrasher et al., 2008). Furthermore, during the chronic phase of recovery, over half of all post-stroke patients continue to experience a loss of mobility in the upper limbs. In addition, the time it takes to restore an upper limb is often much longer than that of a lower limb. One possible explanation is because unit therapy for the upper limb is substantially less extensive than that for the lower limb. Bilateral motor coordination in the upper limbs declines dramatically after a stroke, according to the studies (Lai et al., 2019; Kim & Kang, 2020). This is why one of the most hoped-for outcomes in stroke rehabilitation is increased function in the patient's upper extremities.

Rehabilitation after a stroke is an iterative, goal-oriented process that helps the patient regain as much physical, mental, emotional, linguistic, social, and functional ability as possible. The inability to open one's hand is a common symptom of permanent loss of hand function following a stroke. After a stroke, the goal of rehabilitation is to improve motor skills and function in the affected upper limb (Dimyan & Cohen, 2011). Improving range of motion, static and dynamic control, and muscular strength and stability are the cornerstones of contemporary post-stroke rehabilitation. Despite the fact that studies reveal the importance of trunk control in physiotherapy for stroke survivors, the link between functional impairment and trunk muscles has not been fully explained by clinical investigations (Klnc et al., 2016). Stroke survivors with significant paralysis of the upper extremities, however, have few therapy options and no data supporting them. More rehabilitation appears to be associated with better outcomes (Lohse, Lang, & Boyd, 2014).

Some of the most common therapy modalities for restoring upper-limb function are "conventional," "neuro-physiological," and "motor learning-based" approaches. When it comes to motor recovery after a stroke, physical therapy is essential; nevertheless, its efficacy may be limited in chronic patients. Functional imaging studies conducted after a stroke have revealed elevated activity in otherwise healthy regions of the brain. It has been hypothesized that the development of post-stroke symptoms may be due to a combination of changes in activity in the portions of the brain that were not affected and changes produced by the lesion itself (Kuzu et al., 2021). Several promising rehabilitation strategies for improving hand function in stroke survivors have emerged in recent years. Motor imagery or mental practice techniques (Page, Levine, & Leonard, 2007), which may involve the use of a mirror (Stevens & Ellen, 2004 to reduce upper extremity motor impairment (Richards, Senesac, Davis, Woodbury & Nadeau, 2008). One such therapy is constraint-induced movement therapy (Boake et al., 2007). Constraint-induced movement therapy proved effective in restoring upper limb function in randomized controlled trials of patients with acute and subacute upper extremity paresis who could extend their fingers and wrists (mild paresis) (Wolf et al., 2014). A community-based group exercise program has shown promise in helping people with persistent hemiplegia after a stroke regain use of their affected upper extremity (Pang, Harris & Eng, 2006).

Those with total paralysis will not benefit from these treatments, but those with mild paresis (limited or absent voluntary movement in the shoulder, elbow, or hand) may. Other innovative treatments are emerging as a result of technological developments, such as robot-assisted movement therapy (Kwakkel, Kollen & Krebs, 2008), biofeedback therapy (Cirstea, Ptito & Levin, 2006), and virtual reality training (Merians, Poizner, Boian, Burdea & Adamovich, 2006). On clinical measures like the Fugl-Meyer scale, treatments like those mentioned above have demonstrated improvement for people with mild paresis, but not for those with severe paralysis. Even in patients with chronic (>6 months post-cerebrovascular accident) hemiplegia, improvements in hand function have been shown to be possible because to recent advances in rehabilitation therapy.

Therapeutic techniques like functional electrical stimulation cycling (FES-cycling), whole-body vibration (WBV) and focal muscle vibration (FMV) have shown promising results in the rehabilitation of patients with a variety of neurological disorders. However, there are limitations to some of these treatment options. The FMV, for instance, has shown efficacy in treating upper-limb spasticity. Proprioceptive Neuromuscular Facilitation (PNF) is one alternative treatment that has been shown to be effective in reducing spasticity (Alashram, Alghwiri, Padua & Annino, 2021). Stroke accounts for more than half of all annual deaths worldwide; in Bangladesh, the rate of stroke is 11.39 per 1000 individuals, with the elderly and males being particularly vulnerable (Mondal, Hasan, Khan, & Mohammad, 2022). Even though the hyperacute and acute stages of stroke have been greatly improved upon, patients who still suffer from deficits such as spasticity, upper and lower extremity dysfunction, shoulder and central pain, mobility and gait, dysphagia, vision, perception and communication will still require rehabilitation. Several instruments have been developed and studied to assess functional status, participation, and quality of life after stroke (Hegeds, 2018).

Although most rehabilitation and recovery occur within the first three months after stroke onset (Salbach et al., 2022) some patients continue to make fresh gains many months or even years after beginning. Current guidelines recommend starting therapy while the patient is still in the hospital's stroke unit (Lynch, Hillier & Cadilhac, 2014) and this should be done no later than 3 days after the onset of stroke symptoms. Hospitals, clinics, community centers, programs, and recreation facilities are only some of the places in Bangladesh where people can receive rehabilitation services, and early supported discharge (ESD) services and outreach teams are also available. Many people are unable to access rehabilitation services due to a lack of financial resources or a dearth of qualified medical professionals (Frost & Reich, 2009).

Rehabilitation, whether in a hospital or at home, should begin as soon as possible after a stroke, as doing so is strongly linked to improved functional outcomes (Salbach et al., 2022). Members of the rehabilitation team (including physicians, physiotherapists, occupational therapists, speech-language pathologists, and nurses) use a variety of rehabilitation techniques to aid in a patient's recovery after a stroke. Who they are, what they require, and the facilities at hand all influence how long someone stays and what kind of care they receive. Effective self-directed exercise may be a technique to boost the intensity of rehabilitation with less professional input, time, and costs. Timely rehabilitation can help patients do better and allow them to continue living, working, and participating in the community (Valles et al., 2016). "Patients with some arm movement should be given every chance to practice these activities within their capacity" (Royal College of Physicians, 2016) is a recommendation from their stroke guidelines that lends credence to this notion. Self-directed exercise may help with two things during the early stages of rehabilitation. When given early on, when the brain is more plastic and recovery is more possible (Eng et al., 2014; Murphy & Corbett, 2009), they may first serve as a means of increasing intensity (Eng et al., 2014). According to Bandura (1997), learning to master specific exercises can increase and reinforce self-efficacy, which in turn increases the likelihood of future self-management. Connell, McMahon, Eng, & Watkins (2014) found that 81 percent of therapists provide patients exercise sheets or booklets to do between sessions to strengthen their upper limbs. Reference: (Connell, McMahon, Eng & Watkins, 2014).

Effective arm and hand therapies are recommended as part of evidence-based clinical practice guidelines for stroke rehabilitation (Jolliffe, Lannin, Cadilhac & Hoffmann, 2018). Stroke rehabilitation sometimes disregards these concepts, however (Smaha, 2004). There is obviously a disconnect between what is known (as cited in the guidelines) and what is used in clinical decision making for stroke rehabilitation given the huge variation in adherence rates. According to Grimshaw et al. (2004), an active implementation approach is usually necessary to aid therapists in providing evidence-based care and, by extension, to increase adherence to recommendations in practice. Implementation scientists investigate the science underlying knowledge translation models and undertake tries to improve the likelihood of translating research into clinical practice. It has been stated that initiatives with a high degree of participation and diversity will have the maximum impact, but no "best practices" for execution have been created (Menon, Korner-Bitensky, Kastner, McKibbon & Straus, 2009).

Researchers and end users are encouraged to take a methodical and theoretical approach (Moullin, Sabater-Hernandez, Fernandez-Llimos & Benrimoj, 2015) by all of the theories, models, and frameworks that have been produced to aid in implementation. Only about ten percent of studies that examine the implementation of guidelines are expected to detail the theoretical foundations of the knowledge translation activities they employ (Michie & Abraham, 2004). To better understand health professionals' behavior, previous research has attempted to map perceived barriers and enablers to frameworks like the Theoretical Domains Framework (Craig et al., 2016), but few of these studies go on to develop behavior change interventions. A better understanding of the perceived barriers to address, mapping these to a model or framework to identify implementation activities, and developing a multifaceted package of active interventions are necessary to increase the likelihood of therapist adherence to guideline recommendations, as shown by the available evidence. Stroke rehabilitation guidelines for the upper limb have been the subject of substantial study (Jolliffe, Lannin, Cadilhac & Hoffmann, 2018). However, much more study and development are needed to ensure the success of treatments meant to inspire constructive behavior change. To maximize adherence to clinical advice, organizations have yet to choose which activities to fund and how to do so.

Patients, their families, and any informal caregivers who work closely with the inter-professional rehabilitation team at any point along the recovery continuum are all included in the target audience for these stroke rehabilitation guidelines. In developing the guidelines, experts in Canada considered the most up-to-date research in support of various stroke rehabilitation strategies and therapies. Modules for stroke prevention (Coutts et al., 2014), hyper-acute stroke care (Casaubon et al., 2015), acute inpatient stroke management or stroke rehabilitation (Casaubon et al., 2016) and post-stroke mood, cognition, and fatigue, as well as post-stroke care transitions, have been developed. These guidelines cover 12 different aspects of stroke rehabilitation for people of all ages and degrees of stroke severity, including initial assessment, stroke rehabilitation units, inpatient stroke rehabilitation, outpatient and community-based rehabilitation, arm and hand care after stroke, mobility, balance, and lower limb care after stroke, dysphagia and malnutrition, visual perceptual deficits, central pain, and language recovery. Stroke patients should have access to virtual stroke rehabilitation as an adjunct to or replacement for in-person therapy, according to a recently published recommendation (Salbach et al., 2022).

This study summarizes the research process that led to the creation of evidence-based conservative management for Upper Limb stroke rehabilitation guidelines. Included in these materials are evaluation, outcome measures, decision tools, and templates for preventing and treating stabbing re-injuries, as well as a comprehensive methodology manual and detailed rationales for the recommendations with supporting evidence and health systems implications. It is hoped that by disseminating and encouraging implementation of the guidelines, clinicians' knowledge will grow, patient care will become more streamlined, practice variations will be reduced, efficiency will be maximized, and the outcomes for stroke survivors in Bangladesh and elsewhere will improve.

1.2 : Rationale

There are multiple hospital-based rehabilitation centers where the person with a stroke finds suitable physiotherapy interventions at Bangladesh. Professionals are also practicing followed by evidence-based treatment specially the randomized study from different nation and culture.

A person who has suffered a stroke might go to one of many rehabilitation facilities housed within hospitals. Experts are also changing their methods to align with the data, particularly the results of international randomized controlled trials. In order to reduce muscle tone and increase functional activities, stroke rehabilitation typically employs a variety of approaches, positions, Joint compassion, weight bearing exercise, and modalities.

A number of randomized controlled trials have demonstrated the efficacy of supervised and applied physiotherapy for stroke rehabilitation. The specification of physiotherapy intervention for stroke, including the guidelines for implementing each component, is an area where more study is needed. Evidence from a variety of research shows that improving the upper-limb's functional status is an integral part of stroke recovery.

To the best of my knowledge, no attempt has been made to undertake a review of the available literature in stroke rehabilitation. Physical therapies in stroke rehabilitation can improve recovery rates and quality of life, but the quality of the data linking the two is difficult to assess without a systematic assessment.

1.3 Aim of the study

The aim is to form a series of recommended physiotherapy interventions by ensuring the current and available evidence for the upper limb motor rehabilitation of stroke survivors.

1.4 Objectives of the study

1.4.1 General Objective

To review most recommended physiotherapy interventions by measuring their effectiveness on motor function recovery of upper limb for the stroke patients.

1.4.2 Specific Objectives:

- To gather the information on the effectiveness of various physiotherapy treatment on stroke patients for improving upper limb motor functions from the RCT's study.
- To recommend the proper physiotherapy interventions for stroke patient to improve the upper limb motor functions.
- To establish a comprehensive recomnded physiotherapy guideline for upper limb stroke rehabilitation.

CHAPTER-II LITERATURE REVIEW

The severity of a stroke greatly affects the functional outcomes, making it the leading cause of permanent disability in Western countries. One-third of stroke survivors will be responsible for at least one activity of daily living (ADL) (Carod-Artal & Egido, 2009), and 460 out of every 100,000 will have an incomplete recovery. After 3 months, 20% of stroke survivors will need institutional care, while 50% will regain functional independence. Eighty-five percent of people who suffer a stroke first experience a loss of function in their upper limbs (Cumming, Brodtmann, Darby & Bernhardt, 2014).

Stroke was the third leading cause of death across all income levels in 2001, as reported by the World Health Organization. About 5% of all global stroke fatalities. Stroke affects roughly one in every twenty persons (aged >14) according to data gathered from industrialized nations. While low-income nations have a wide range of stroke mortality and burden statistics (Feigin, Lawes, Bennett, Barker-Collo & Parag, 2009), these numbers still need improvement. Studies have measured short-term outcomes, primarily in the realm of impairments and disability, despite the fact that stroke is a chronic condition (Sinden, Hicks, Stroemer, Vishnubhatla & Corteling, 2017). In 1980, the World Health Organization (WHO) established an international taxonomy of impairments, disabilities, and handicaps. Seventy-six percent of people die from stroke, seventy-six percent are impaired, 42 percent are disabled, and only 2 percent are handicapped (Patel et al., 2006).

Stroke rates in Bangladeshis aged 40-49, 50-59, 60-69, 70-79, and 80 and older are estimated at 20%, 30%, 0%, 1%, and 1%, respectively. there is The ratio of male patients to female patients is 3:14:2:41 (Rizvi et al., 2013), stroke was predicted by Burdea, Cioi, Martin, Fensterheim & Holenski (2010) as the leading cause of disability worldwide. All genders and ages can be affected, but it is more common in the elderly. Stroke impairs the ability to sustain movement and can impair motor, sensory, and cognitive functions. Upper extremity hemiplegia (UL) is one of the most severe effects of stroke and the major underlying disability after stroke. Daily activities such as moving a paralyzed arm and opening an injured hand are associated with successful stroke recovery.

The incidence of stroke in India is estimated to range from 44 to 843 cases per 100,000 people. The majority of Pakistan's information comes from case series collected in hospitals. The estimated annual incidence of stroke in Pakistan is 350,000 (Elshaikh, 2021), with a prevalence of 250 per 100,000 people in the country. Stroke and transient ischemic attack are estimated to affect 21.8% of adults aged 35 and up in a recent study of an urban slum in Karachi. The average age of stroke victims was 45 in another population-based study conducted in the northwest of Pakistan and Afghanistan. The stroke rate among women in Pakistan is higher than that of men, and the stroke age gap is even narrower. Very high stroke trend estimates in these two demographic studies can be muddled by case-by-case complications (Pandian et al., 2020). Sri Lanka has about 20 million people, and 9% of every 1000 of them suffer from a stroke each year (Ranawaka & Venketasubramanian, 2021). There is a lack of data regarding the incidence of stroke in Bangladesh, but one study indicates a rate of 3 cases per 1,000 individuals. Slight shifts can be seen in the estimated stroke of stroke across all South Asian countries. Afghanistan, Nepal, Bhutan, and the Maldives all have a complete lack of data (Isuru et al., 2021).

Ischemic stroke (IS) is ten times more common than hemorrhagic stroke (HS) in Western countries. Compared to IS, HS is thought to have a greater fatality rate. Previous research has shown that people with HS had a higher risk of dying from a stroke. Elepola et al. (2022) found that some risk variables are shared by both HS and IS. Although a link between diabetes and ischemic heart disease is widely accepted, the relative importance of risk factors like hypertension, tobacco use, and alcohol consumption remains up for debate. In March of 2001 the Danish government established a countrywide Stroke Registry to keep track of all hospitalized stroke victims. There were 39,484 patients in the register as of February 2007 and 3,993 of them had HS (Syed, Khatri, Alamgir and Sayay, 2022).

The World Health Organization reports that developing nations account for an estimated 86% of all stroke-related fatalities worldwide. The number of stroke deaths in South Asia is estimated to be more than 40% of all stroke deaths worldwide. Stroke and heart disease strike this area more than a decade before the rest of the world, suggesting that heart disease may be a more significant risk factor for stroke here. Human resources (neuroscientists and stroke experts) and financial resources are scarce in South Asian countries despite the region's high prevalence of stroke (Wasay et al., 2014).

Stroke ranks third among female causes of death and fourth among male causes of death in the United States. While men have a slightly higher risk of having a stroke, women have a higher risk of dying from a stroke (68 vs. 44 per 100,000 in 2002) due to their higher average age. Stroke survivorship is lower for women compared to men, according to a number of studies. Women are disproportionately affected by physical impairments and restrictions in ADL, or fundamental aspects of self-care. Stroke has a greater impact on women than men in terms of cognitive impairment, depression, and fatigue, and overall quality of life (QOL) (Gargano et al., 2007).

Stroke is another leading cause of illness and death in the UK. A recent study found that between 2002 and 2004, between 1.36 and 1.62 strokes per 1,000 population were recorded in the United Kingdom. A study found that Scotland has a high proportion of older people, with the incidence increasing by 2.8 per 1,000 people per year. More than 46,000 people have died from stroke in England and Wales. Stroke prevention is a top priority in current UK public health policy. Hypertension, brain, high cholesterol, atrial fibrillation, and diabetes are all important risk factors that require better management (Lee et al., 2011).

In Germany, some 200,000 people per year experience their first stroke, with another 60,000 experiencing a stroke after having one or more pre-stroke symptoms. Ischemic stroke accounts for around 80% of all stroke, while hemorrhagic stroke accounts for about 20%. More than a quarter of stroke patients are younger than 65. Risk factors (high blood pressure, tobacco use, insufficient physical activity, excess body fat, and others) are crucial in development of vascular illnesses, which lead to stroke. Adjustments can be made easier with the help of medications and a change in lifestyle (Knecht et al., 2011).

Stroke mortality rates are significantly lower in western European countries compared to those in eastern European countries, according to regular mortality statistics. In Singapore, stroke injury accounts for 4.03% of the population and averages 1.8 per 1000 people over the age of 50. In the European region, this proportion is expected to rise to 35% in 2050 from 20% in 2000, and the median age group is expected to increase from 37.7 years in 2000 to 47.7 years in 2050 (Truelsen et al., 2006).

Stroke is the third leading cause of mortality in Thailand. Many of the effects of stroke have worsened over time, despite survivors' initial resistance to change: after 12 months, about half of stroke survivors need assistance with activities of daily living and self-care. Hospital readmissions, social service requirements, and rehabilitation facilities all remain high because of it. Stroke survivors face a multiplicity of challenges, including the disease itself, physical limitations, and isolation (Van et al., 2015). There are about 75,000 strokes annually in South Africa, making it one of the leading causes of death and disability there. In 2011, there were 33,500 strokes out of a total population of 13,100,000. This was a disproportionately high burden in rural South Africa. Stroke is very common, and a study of 7740 stroke survivors found that over half of the patients were younger than 65 and about a third were younger than 55. Young stroke survivors experience more severe consequences than their older counterparts because of the greater number of years they have spent contributing to society and the economy. Young stroke survivors may need extensive rehabilitation to return to normal life and the workforce (Maredza, Bertram & Tollman, 2015).

Due to limited rehabilitation resources, time constraints, and a lack of early motor recovery in the arm and hand, the focus of therapy is often shifted to restoring balance, gait, and general mobility (Lee, Kim & Lee, 2016) despite the fact that the majority of stroke survivors regain independent ambulation. Because of these factors, early one-handed compensatory training to enhance functional abilities has been prioritized over therapy of the underlying motor deficiencies. Less funding has gone toward therapies that may improve motor function for the paretic upper limb because of poor functional outcomes (Hartwig, Gelbrich & Griewing, 2012). The persistently impaired paretic upper limb recent studies (Mihara et al., 2012) to benefit from therapy-induced improvements in motor skills even more than 6-12 months after stroke.

Roughly half of those who survive a stroke are left with one arm that doesn't work. Activities such as gripping, holding, and moving things demonstrate functional recovery of the upper limb, but even 3-6 months after the stroke, these everyday tasks are still impaired in 55% to 75% of stroke survivors. "Long-term Follow-up After Stroke (The LAST-long Trial), 2019"Upper limb function recovery in stroke patients is typically poor.

Using the Rivermead Motor Assessment Scale and the Barthel Index, a study found that German stroke survivors (n = 66) had superior functional recovery 6 months after stroke than SA patients (n = 56) (p = 0.0003 and 0.003, respectively).

The South African study sample and the German study sample did not significantly differ in terms of age, gender, aphasia, or time since stroke onset. All stroke survivors participating in the German experiment received care from a multidisciplinary team. In addition to physiotherapy, only patients from 16 of the 21 health centers in the SA study sample received speech therapy and occupational therapy; everyone else received it (Rhoda et al., 2014). Many daily actions include the use of both upper limbs (ULs) in a complimentary manner to achieve a goal (eg, writing with one hand while stabilizing a piece of paper with the other hand). As a result, recovery of bilateral UL function following a stroke is desirable (Waller & Whitall, 2008). Previous research has demonstrated the differential between capacity and performance, with subjects more likely to use their non-paretic limb during spontaneous task settings (ie, motor performance) despite acceptable motor capability of the paretic UL exhibited during forced usage (Han et al., 2013).

Most rehabilitation units devote a large part of their resources to treating strokes. As a result, the capacity to predict functional outcome accurately is critical and serves as the foundation of successful rehabilitation medicine treatment. In general, the return of active motions and functional abilities in the hemiplegic upper limb is less than that in the leg (Buma, Kwakkel & Ramsey, 2013). Raghavan (2015) documented the course of recovery of arm motions following stroke, noting that the restoration of "proprioceptive facilitation" and a "proximal traction response" within 2 weeks was a favorable prognostic marker for voluntary movement recovery. Several writers have found that the severity of upper extremity weakness at the time of initial evaluation has a strong correlation with the result of upper limb mobility and function. Research on Trajectory Optimization of Upper Limb Rehabilitation Robot, (2022) found that paresis on admission corresponded strongly with function on release in a prospective study of 75 consecutive hemiplegic patients. In his study, half of the patients with a paresis score of 3 or above on the Medical Research Council scale restored independent limb function following rehabilitation, while the other half were able to execute extremity function with very moderate help. Only 8% of individuals with a paresis score of or below regained independent extremity's function.

Recent research by Kakuda, Abo, Nakayama, Kiyama & Yoshida (2013) found that only one of five patients with initial severe upper extremity paresis restored complete function, whereas four of five patients with mild paresis regained fulsome function. This suggests that early motor deficit and loss of position sensation in the arm, as measured at the initial evaluation, are independently associated with poor recovery of the hemiplegic upper limb.

Despite these studies, it is still difficult to predict an individual patient's prognosis with regards to upper limb function when SEP is absent. Korpershoek, Bijl & Hafsteinsdottir (2011) found an even stronger link between missing SEP and poor recovery of upper extremity function in aphasic individuals with severe hemiplegia. Of the 42 patients in their study, 41 showed no restoration of function in the hemiplegic upper limb.

Neurobiology, movement sciences, dynamical systems theories and the International Classification of Function (ICF) are frequently used to frame physical therapy and stroke rehabilitation (Meyer, Karttunen, Thijs, Feys & Verheyden, 2014). According to this conventional architecture, reduced integration of somatosensory input from the skin, joints, and muscles after a stroke is thought to result in dysfunctions in the perception and action subsystems and jeopardize the ability of the overall system to perform ADL. The body is viewed as a biological and biomechanical system, holding a third-person perspective, even though various subsystems (inside the individual, the task, and the environment) influence one another. As seen in the aforementioned sensory discrimination therapies, this understanding of the body allows for the consideration of various impairments in isolation, such as somatosensory dysfunction apart from motor and perceptual abnormalities (Winstein, Lewthwaite, Blanton, Wolf & Wishart, 2014).

Because of damage to the areas of the brain responsible for movement planning and execution, such as the primary motor cortex and anterio-orbitofrontal cortex, more people are now experiencing chronic post-stroke symptoms, Wolf et al. (2016) estimate this is primarily due to the pervasive and persistent difficulty using the upper extremities.

Rand & Eng, (2015) showed in a study, up to 70% of stroke survivors have difficulty using their upper limb for major tasks (UL, arm, and hand). One assumption is that when a stroke survivor exhibits a change in activity, it is backed by an uptick in their performance and capacity (i.e., what they can do in a clinical context) (i.e., do they actually utilize their UL in situations outside of the clinic). After a stroke, it is unlikely that UL recovery would be as simple. It may be useful to comprehend how capacity and performance change over time after a stroke in order to choose which individuals to target and when during their recovery. Different recovery features have been seen during inpatient and outpatient rehabilitation in previous studies. First, survivors of a stroke may have improvements in both capacity and performance. Additionally, survivors may exhibit improved capacity but not necessarily improved performance (Bernhardt et al., 2017). Not to mention, survivors may not see much of a change in their capacity or performance. A performance improvement but not a capacity improvement is not supported by the literature. These traits support our claim that UL capacity and performance are separate but related factors that call for independent measurement (Rand & Eng, 2011).

Other studies have shown these after high dosage behavioral treatments but it is still impossible to tell whether additional improvements are backed by actual recovery or compensation using the parameters used in previous analyses (Bernhardt et al., 2017). Despite these findings, less than 11% of all lower limb and upper limb recovery trials (UL) enrolled patients on average less than 30 days after the stroke began.

Successfully reducing the long-term effects of stroke and achieving the best possible functional recovery for community reintegration are both highly dependent on neuro-rehabilitation as shown by Pekna, Pekny & Nilsson, (2012). Neuroplasticity is the primary cause of this improvement in functional outcome, making it an integral part of the rehabilitation process for stroke victims.

Robotic verticalization enables strengthening exercises involving body weight shifting from one leg to the other, which are difficult for individuals who have suffered a major stroke to perform. According to certain studies, more cerebral blood flow modulation during robotic verticalization compared to physiotherapy verticalization may further enhance plastic changes in the vestibular system, sensory-motor regions, and brain, improving motor and cognitive performance (Wist, Clivaz & Sattelmayer, 2016). Post-stroke therapy has commonly focused on reducing motor impairment and decreasing physical handicap through functional reconfiguration of the brain when injured brain regions are not recruited to fill up lost motor functions. The rise of human-machine interactions in virtual reality and other technological advancements like enhanced robotic design have a positive impact on many more modern post-stroke rehabilitation treatments. These technologies are being studied to provide more effective ways to cure the physical disabilities caused by damage from strokes (Roy et al., 2010).

Dimyan & Cohen (2011) estimated that the ipsilateral hemisphere displayed more inhibition when only one arm was activated. It is unclear, nevertheless, whether the changes in cortical excitability result from the healthy limb being overused as a form of compensation or from the damaged limb not being used at all. These findings are consistent with the hypothesis that lowering the excitability of the healthy hemisphere can help restore motor function to the paretic limb after a stroke. Primarily consists of passive mobilization or electrical stimulation because the majority of the currently available therapies require that residual voluntary activation of muscles or partial movements be present. Most research on bilateral arm training has focused on the functional improvement of the injured limb, and in the majority of these studies, the motor training is provided by robotic devices that perform passive movement of the injured arm and active movement of the unaffected limb (Waller, 2014).

Stroke can result in upper limb impairments that impair hand and upper limb function, including shoulder subluxation with or without discomfort. Constraint-induced movement therapy (CIMT), mental practice, mirror therapy, virtual reality, therapies for sensory impairment, and a lot of repetitive task practice were all found to be helpful for upper limb rehabilitation after stroke (Pollock et al., 2014). Because there aren't many upper limb physiotherapy intervention studies in South Africa, it's important to look at pertinent international literature to find evidence-based tactics that can be used in settings with low resources, possibly alter them, and then assess their efficacy in SA. For instance, interventions needing extensive and protracted one-on-one therapy or those involving robots would not be suitable in low socioeconomic contexts. Interventions include mirror therapy, mental practice, modified CIMT, high-dose repetitive practice, and home workout programs employing equipment that can be found in most homes are all potentially appropriate and need additional investigation (Ntsiea, 2019).

A study was conducted in Gauteng, South Africa, by (Kara & Ntsiea, 2015) in which therapists often recommend patients begin unsupervised home exercise programs after discharge because they may not be able to monitor every aspect of therapy, especially at home.

Dennis et al. (2011) showed that remarkable technique to enhance the outcomes of rehabilitation is to lengthen, increase the number of repetitions and intensify each session. However, larger dose clinical trials have not greatly advanced in a way that can change clinical results, whether they were conducted in the early or chronic stages. Additionally, the best stroke rehabilitation strategy for restoring upper limb motor function. According to a recent Cochrane review, there is still inadequate high-quality evidence to confirm the superiority of any widely used intervention for stroke-related improvements in upper extremity function. Interventions for stroke therapy that aim to enhance functional outcomes for the injured upper limb are rapidly developing and expanding. To maximize functional recovery, innovative interventions must be secure and adhere to motor learning principles. Combination therapies, which combine two often distinct therapies, are one of these novel therapy techniques. when interventions are integrated, the positive effects from each modality work together to produce results that are bigger than what each modality would have produced on its own (Mathieson, Parsons & Kaplan, 2014).

CHAPTER-III: METHODOLOGY

Study design: Systematic review

Types of studies

Researcher included published studies in which the cases diagnosed as stroke, Studies that mentioned intervention regarding upper limb physiotherapy for stroke, Articles found within the time range January, 2012- December, 2022, outcome based on Pain, Spasticity, ROM, Strength, Balance, Gait & Disability. Only Randomized Controlled Trials (RCTs) in English language were included. Quasi-Experimental, Pilot Randomized Control Trial, any Study Protocol and Controlled Clinical Trials (CCTs) were excluded.

Types of participants

- The participants were eighteen years or older, who suffered from acute (less than 6 weeks), subacute (6 to 12 weeks) or chronic (longer than 12 weeks) stroke and the survivors categorized as Stroke, Ischaemic Stroke or Haemorrhagic Stroke.
- Participants who have difficulties in upper extremities motor function after stroke.
- Participants who had Transient Ischemic Attack (TIA) or other neurological conditions rather than stroke were excluded from the study.

Types of interventions

The study included all randomized control trials that clearly described hands-on physical intervention (Manual therapy techniques), Exercise therapy, Electrotherapy, Robotic therapy, Virtual reality, combined therapeutic intervention or treatment component schedules (Home exercise), for the upper limb following stroke, either as the experimental intervention or as the control group. Author did not include pharmacological, Operative, psychological (for example, mental imagery) speech language therapy, prosthetic & orthotic or occupational therapy techniques. Here, only reviewed the trials with interventions that address with upper limb physical impairment. The researcher included interventions delivered during the acute, sub-acute or chronic stages of rehabilitation. This review focused on studies that included descriptions of specific hands-on motor interventions and techniques rather others.

Types of outcome measures

The outcomes of interest were decreased pain (for example a Numerical Rating Scale or Visual Analogue Scale), reduced spasticity (for example MAS-Modified Ashworth), improved function- (FUGL-meyer assessement for upper extremities), Improved strength (for example MMT- Manual muscle testing or Oxford Muscle Grading Scale), improved range of motion (for example Goniometer), balance (for example Berg balance scale) and reduced disability (for example Modified Barthel index or Oswestry Disability Index Scale).

Search methods for identification of studies

References of retrieved articles were independently screened by two review authors. The search for this review was part of a comprehensive search on physiotherapy & therapeutic modalities. These databases were searched for this update from January 2012-December 2022.

We searched the following databases

- PubMed
- PEDro
- Web of Science
- Scopus Index
- Cochrane (Anexure-1)

Subject headings (MeSH descriptors) and keywords (in PICO format) and the Boolean operators included the following terms:

Table 01: The PICO formats

P=Population	(((((Stroke) OR (Hemorrhagic stroke)) OR (Ischemic stroke)) OR (Cerebrovascular accident)) OR (Cerebral infarct)))
I=Intervention	AND (((((((((Physiotherapy) OR (Physical Therapy)) OR (Upper limb physiotherapy)) OR (Upper limb rehabilitation)) OR (Upper limb rehabilitation exercise)) OR (Upper limb motor training)) OR (Upper limb task-oriented activity training)) OR (Upper limb virtual rehabilitation)) OR (Upper limb robotic therapy)))
C=Comparator	NOT ((((((Only medication) OR (Post operative)) OR (Only surgery)) OR (Occupational therapy)) OR (Speech language therapy)) OR (Orthosis Prosthesis))
O=Outcome	AND ((((((decreased pain) OR (Reduced spasticity)) OR (Improved function)) OR (Improved strength)) OR (Improved balance)) OR (improved range of motion)) OR (reduced disability)))

Table 02: Preferred Reporting for Systematic Review and Meta-Analysis (PRISMA)

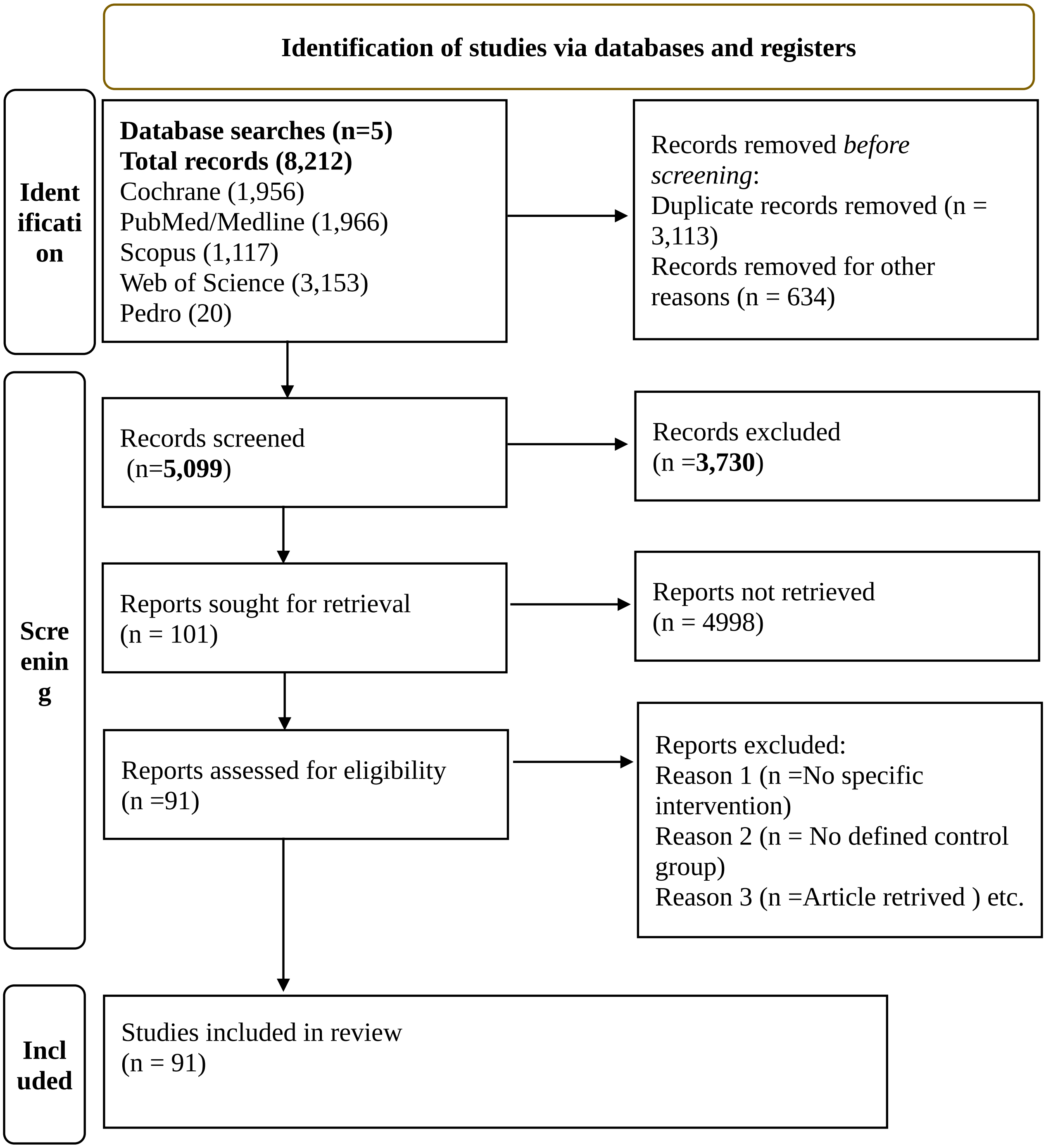

Figure 1: Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram for study inclusion

Data collection and analysis Selection of studies

The systematic evaluation had been developed according to with the PRISMA guidelines, and "Rayyan" software had been employed to make sure the screening. The citation analysis and research selection were carried out separately by two review authors. Each form underwent a pre-pilot. When there was persistent disagreement, each pair of review authors sought a third author's opinion. Using the quadratic weighted Kappa statistic and Cicchetti weights, disagreements (included, maybe, excluded) were evaluated for research selection (Landis 1977).

Data extraction and management

The abstraction of information had been carried out independently by two review authors. Forms were pre-piloted before usage. The following information was gathered: the procedures (RCT type, number of analyses, number of randomizations, intention-to-treat analysis), the subjects (disorder subtype, duration of disorder), the interventions (treatment characteristics for the treatment and comparison groups, dosage and treatment parameters, co-intervention, treatment schedule), the results (baseline mean, reported results, point estimate with 95% confidence intervals (CI), power, side effects, and costs of care) and the notes.

CHAPTER-IV RESULTS

Description of studies

4.1: Search strategy results

The researcher identified a total of 8212 articles as possibly relevant during the initial searches of all selected sources. However, after removing the duplicate, we found the majority not to be relevant during the initial stage of screening of the study title and abstracts. Author obtained copies of all relevant trials following a second stage of screening and we finally identified 91 articles for inclusion.

4.2. General and specialist electronic bibliographic database search results

4.2.1: PubMed (MEDLINE), Cochrane, PEDro, Scopus, Web of Science (January, 2012 to December, 2022) search results

Author identified a total 1956 (**Cochrane**), 1966 (**PubMed/Medline**) 1117 (**Scopus**), 3153 (**Web of Science**) and total 8212 potentially relevant studies from the search (Date; Time: 25/10/2022; 22:43:28). After duplicate remove, author found 5099 articles for initial screening. Following initial (Title & Abstract) screening we obtained 101 papers for assessment. Following the second stage of screening included 91 papers for the quality and biasness analysis (RoB2) in the review. This process is shown in Annexure-2.

4.3: Study assessment results

Following identification of the ninety-one trials for inclusion in the review, resercher undertook the two processes of data extraction (Supplementary file-03, Excel-worksheet -01) and quality assessment by RoB2 tools (Supplementary file-04, Excel-worksheet -01). The results of these two processes are described in the following section.

4.3.1: Participant information

In total, 6528 participants were investigated across the three studies included in the review. A summary of the participant information is shown the features of the studies that were included (Annexure-03).

Each of the included investigation (article) provided information on mean age. When assessed collectively across all of the studies, this was 46.5 years. Two studies (Wang et al., 2019; Patricia et al., 2019) reported age ranges ranging from 18 to 76 years. The studies provided inconsistent information regarding the site of lesion. 78 studies made report on both type of stroke, one reported side of hemorrhagic, eight studies made report on only ischemic and four studies didn't report without any mentioned location. In total, the time range of post stroke across the ninety-one studies from one week to six years.

4.3.2: Assessed outcomes

A number of different primary outcome measures to assess the impact of the intervention under investigation were used by each of the ninety-one studies.

Among the included article seventeen studies focused on the exercise therapy as the intervention, ten studies focused on the Manual therapy, twenty-two studies focused on the virtual reality, Gamming or Robotic therapy, four studies focused on the combination of multiple intervention, only one study focused on the on-home exercise and rest of the articles focused on the on Electrotherapy for the improvement of upper limb motor function of stroke survivors.

4.4 Interventions

All the included studies utilized different interventions for different outcome. These are categorized and summarized below and briefly recorded at supplementary file -03.

Table-03: Exercise therapy for improvement of upper limb motor function of stroke survivors

Author	**Setting**	**Intervention**	**Dose**	**Outcome**	**Remarks**
Brunner, Skouen & Strand, (2012)[1]	Norway	Bimanual Training CIMT	4d/week for 4 weeks, 2-3 hr/daily	Upper limb function	Both was effective in improving arm function.
Corti et al., (2012)[3]	United States	Dynamic resisted training (Power), Functional task practice (FTP)	90 mins/ session, 3 sessions/week, Total 30 sessions for 10 weeks	Hand function	Powe prior to FTP may enhance the benefits of repetitive task practice.
Morris and Wijck, (2012)[9]	America	Practied identical task simultaneously with both arm	20 min per day, 5days/week, 6 weeks	Hand function	Lead to clinically small improvements in ipsilesional performance
Sebastiano et al., (2014)[18]	Italy	Arm supportive alone with physiotherapy	30 minutes session, 6 days a week, 2 weeks	upper limb arm support	Rehabilitation training using an arm weight support device is more effective than conventional physiotherapy only
treger et al., (2013)[22]	israil	Modified Constraint-Induced Movement Therapy	5 sessions/wk for 2 wks, 45 mins of physical therapy	upper limb function	CIMT may facilitate functional improvement of a plegic hand

Luca et al., (2015) [25]	romania	mechanical therapy	10 repi with 3 min rest	functional activity and muscle strength	improve functional activity and muscle strength
da silva., (2015)[26]	brazil	task oriented movement (uni and bi lateral functional exercises and exercised in multiple movement planes) and the control group given conventional therapy	10 repetition the same movement 3 min resting period	motor recovery	showed improvement of the motor recovery and enhances functional performance of a paretic hand
Arya et al., (2018)[50]	India	Task based mirror therapy	40 mins/session, 5 session/wk, for 6 wks	Sensory, motor functions	The mirror illusion induced by MT may be utilized for sensory and motor deficits as well as for the more affected and less affected hands.
Najafabadi et al., (2018)[54]	Iran	Compitative and non compitive vollyball exercise	60min/d volleyball exercise + 30min/d traditional rehabilitation3d/wk for 7wk	UE motor and sensory function	Both volleyball exercise groups demonstrated significant improvement in sensory and motor function as well as greater execution of both reach and grasp movements.
Jan et al., (2019)[63]	Pakistan	Motor Relearning Programme (MRP) Mirror therapy (MT)	6 weeks, 3 days per week, 2-hour session per day	Motor function	MRP and MT were found to be effective in improving upper limb motor functions of stroke

					patients, but the MRP was more effective than MT
Wang et al., (2019)[68]	China	Tui Na plus conventional rehabilitation	40 min/session, 5 days a week, 4 weeks	Spasticity	Tui Na was effective and safe four alleviating post stroke spasticity
Chinnavan et al., (2020)[70]	Malaysia	Cnventional therapy + mirror therapy	30 minutes + 15 minutes, 3days/week.	Motor function	Combination of conventional and mirror therapy is an effective method on restoring upper limb motor function among hemiplegic patients
Madhoun et al., (2020)[72]	China	Task-based mirror therapy Conventional therapy	25 mins /day for 25 days	Motor function	The study shows the combination of conventional rehabilitation treatment and TBMT is an effective way to improve the functional recovery in the upper limb stroke patients
Natta et al., (2020)[73]	Africa	Rehabilitation equipment kit, including a daily note ,self rehabilitation protocol and pictures describing therapeutic exercises	2 hours, 6 days a week for 8 weeks	Muscle strength, Motor function	Self-rehabilitation program, improved muscle strength, upper limb activity and quality of life chronic stroke individuals

Renner, Brendel & Hummelsheim, (2020)[74]	Germany	Bilateral arm training	Twice daily over 6 weeks	Motor function	The benefits of bilateral arm training followed by repetative bilateral hand training for motor control of the severely paretic upper limb may depend on lesion location. Further studies with larger sample size are required for the validation of these results.
Erimov et al., (2021)[79]	Turkey	Isokinetic strengthening exercise	12 sessions, 3 times a week for 4 weeks	Muscle strength	Almost all clinical measures improved significantly by time in isokinetic group
Neris et al., (2021)[81]	France	Gravity-supported, game based training using an exoskeleton. Self rehabilitation (basic stretches and active exercises)	4 weeks	Motor function	No significant between-group difference

Table-04: Manual therapy for improvement of upper limb motor function of stroke survivors

Author	Setting	Intervention	Dose	Outcome	Remarks
Huseyinsinoglu et al., (2012)[5]	Turkey	Bobath Concept CIMT	1hr/day for 10 consecutive weekdays	arm function	CIMT seems to be slightly more efficient than the Bobath Concept in improving the amount and quality of affected arm use.
Van et al., (2015) [17]	Netherland	Modified Constraint induced movement therapy, Modified bilateral arm training with rhythmic auditory cueing	60 min/day, 3 day/week, 6 weeks	functional recovery	Each other are equally significant in improving upper limb motor function
cathy et al., (2013) [21]	new zealand	Bilateral Priming (Device-assisted mirror symmetrical bimanual movements)	15 min/d, 1249 rep/d, 19 day, Therapy= 30 min/d	recovery of upper limb function	Bilateral priming accelerated recovery of upper limb function in the initial weeks after stroke.
ji luo et al., (2015)[27]	taiwan	Computer-aided interlimb force coupling training task with visual feedback included different grip force generation methods on both hands	30 min/day, 3 days/week, 4 weeks, 12 sessions	upper limb motor function	showed improvement of the motor recovery and enhances functional performance of a paretic hand
Jourdan et al., (2017)[44]	France	Passive joint mobilization	45 min session/day, 3 days/wk, 3 sessions/day, 6 wk	UL rehabilitation	Within a comprehensive rehabilitation programme, IS did not show superiority to passive mobilization for UL rehabilitation.
Lee et al., (2017)[45]	Korea	Bilateral arm training General occupational therapy	30mins, 5 times a wk for 8 wks	UL function, ADL	Bilateral arm training along with general occupational therapy might be more effective than occupational

					therapy alone for improving upper limb function and ADL performance in hemiplegic stroke patients.
Agnol & Cachetti., (2018)[52]	Brazil	Acupuncture (ACP)	12 sessions, 3 Times/wk	Spasticity, ROM, Speed	Acupuncture was effective in reducing spasticity and increasing ROM of paretic upper limb after stroke, but did not contribute significantly to speed and quality of movement.
Antoniotti et al., (2019)[58]	Italy	Mirror therapy + Conventional Rehabilitation Programme	30 mins/session, 5days/wk for 30 days and Conventional = 45mins/session, twice daily,5 days/wk	Upper limb function	Compared with Sham therapy, mirror therapy did not add additional benefit to upper limb recovery early after stroke
Hung et al., (2019)[62]	Taiwan	Bilateral Hybrid Training (BHT) Rehabilitation training (BHT+Unilateral HT)	90 min/d 3 d/wk for 6 weeks	Motor function	BHT was more effective for improving upper extremity motor function, particularly distal motor function
Parikh et al., (2022) [89]	Saudi arabia	Conventional therapy with tennis ball myofascial release	6 sessions (35 mins/ session)/weekfor total 4 weeks	spasticity and motor function	Myofascial release performed with a tennis ball in conjunction with conventional therapy has more beneficial effects on spasticity and motor functions of the upper extremity in patients with chronic stroke compared to conventional therapy alone.

Table-05: Electrotherapy for improvement of upper limb motor function of stroke survivors

Author	Setting	Intervention	Dose	Outcome	Remarks
Corti et al., (2012)[3]	United States	Dynamic resisted training (Power), Functional task practice (FTP)	90 mins/ session, 3 sessions/week, Total 30 sessions for 10 weeks	Hand function	Powe prior to FTP may enhance the benefits of repetitive task practice.
Gan-Aslan et al., (2012)[4]	Turkiye	Electromyographic biofeedback (EMG-BF) and Neurodevelopmental and conventional therapy	5 times a week, for 20 minutes per session for 3 weeks	Upper limb function	A positive effect of EMG-BF treatment in conjunction with neurodevelopmental and conventional methods in hemiplegia rehabilitation
Knutson et al., (2012)[6]	US	Contralaterally Controlled Functional Electrical Stimulation (CCFES)	15 mins/set x 3 sets x (2sets/day x 5day/wk + 1set/d x 2d/wk) + 90 mins/lab x 2 labs/wk=12hr/wk	Hand function	The results favor CCFES over cyclic NMES though the small sample size limits the statistical power of study.
Han et al., (2013)[8]	China	Contralaterally Controlled Functional Electrical Stimulation (CCFES)	15 mins/set x 3sets x (2sets/day x 5day/wk + 1set/d x 2d/wk) + 90 mins/lab x 2 labs/wk=12hr/wk	improve upper limb function	The results favor CCFES over cyclic NMES though the small sample size limits the statistical power of study.
Rosewilliam et al., (2012)[11]	United Kingdom	sNMES addition to standardized upper limb therapy	at least twice a day for 5 days a week for 6 weeks	Hand and grip strength	Patients with no functional arm movement, electrical stimulation of wrist extensors improves muscle strength for wrist extension and grip.

Boyaci et al., (2013)[12]	Turkiye	NMES(both active and passive) combined with neurophysiologic exercise treatment	45 min five times per week for 3 weeks	Hand function	Patients who received NMES(both active and passive) combined with neurophysiologic exercise treatment improved paretic UE motor function and decreased functional dependence in subacute and chronic stroke patients.
Kim et al., (2013)[13]	South korea	FES combined with mirror therapy	30 minutes/day and 5 times/week for 4 weeks	Motor function of hand	combined FES and MT could be effective at restoring motor function poststroke
Opara et al., (2013)[14]	poland	EMG triggered (active) NMES	at least twice a day for 5 days a week for 6 weeks	motor function of hand	Electrical neuromuscular therapy might be beneficial in rehabilitation programs because NMES (both active and passive) combined with neurophysiologic exercise treatment improved paretic UE motor function and decreased functional dependence in subacute and chronic stroke patients.
Noma et a., (2013)[15]	Japan	Electrical neuromuscular therapy might be beneficial in rehabilitation programs because NMES (both active and passive) combined with neurophysiologic exercise treatment improved paretic UE motor function and decreased functional dependence in subacute and chronic stroke patients.		upper limb motor function	Electrical neuromuscular therapy might be beneficial in rehabilitation programs because NMES (both active and passive) combined with neurophysiologic exercise treatment improved paretic UE motor function and decreased functional dependence in subacute and chronic stroke patients.

Theime et al., (2012) [16]	Germany	Electrical neuromuscular therapy might be beneficial in rehabilitation programs because NMES (both active and passive) combined with neurophysiologic exercise treatment improved paretic UE motor function and decreased functional dependence in subacute and chronic stroke patients.	30 mins/session, 20 sessions/wk, for 5 wks.	sensorimotor function	No effect on sensorimotor function of the arm, activities of daily living and quality of life of mirror therapy compared to a control intervention after stroke. A positive effect on visuospatial neglect was indicated.
Danial et al., (2014) [23]	usa	machine based therapy	3 hr pr week in 3 week	upper limb function	machine improve the upper limb function
hyungu, (2015) [24]	korea	repetitive Transcranial Magnetic Stimulation (rTMS) + Comprehensive Rehabilitation Therapy(CRT	(rTMS = 20 min ,CRT=30 min) per day, 10 min rest period halfway through the session , five days per week for four weeks.	upper limb motor function	significantly improved upper limb motor function
holcomb et al., (2015)[28]	usa	G-1: Functional electric stimulation plus motor learning (ML), G-2: Robotics plus ML	3.5 hr/d of ML, 1.5 hr/d of FES, 1.5 hr/d of Robotics; 5 d/wk(60 sessions)	upper limb motor learning	All 3 treatment groups demonstrated clinically and statistically significant improvement in response to treatment
sadaati et al., (2015)[29]	iran	Repetitive transcranial magnetic stimulation (rTMS) along with conventional physiotherapy	20 minutes, 10 sessions	hand function	rTMS combined with regular physiotherapy can significantly improve hand function

Kuntson et al., (2016)[32]	USA	Contralaterally controlled electric stimulation Cyclic neuromuscular electric stimulation	2 sessions per week for 12 weeks	Motor function	There was no difference betwwen groups in chanfe in motor function over time
Kwakkel et al., (2016)[33]	Netherland	EMG triggered neuromuscular stimulation Modified CIMT	60 min daily, 3 weeks	Hand function	No statistical difference between two groups
Aşkın, Tosun & Demirda., (2017)[38]	Turkey	low-frequency repetitive transcranial magnetic stimulation	10 sessions, 5d/wk, 2 weeks	Motor function	TMS is proven to be more effective than conventional physiotherapy.
Chuang et al., (2017)[42]	Taiwan	EMG-triggered NMES	3 days/week for 4 weeks	Pain	reduce shoulder pain
Yuzer, Donmez & Ozgirgin., (2017)[46]	Turkey	Functional electrical stimulation (FES)	30 minutes a day for 5 days /week , 20 session	Spasticity, ROM, Motor function	FES is an effective method to reduce spasticity and to improve ROM, motor and functional outcome in hemiplegic wrist flexor spasticity.
Carrico et al., (2015)[51]	USA	Somatosensory stimulation	2 hour daily motor trainning for 10 consecutive weeks days	UE function, paresthesia	Somatosensory stimulation can improve objectives outcomes of motor training for moderate to severe hemiparesis less than 12 months after stroke
Zhou et al., (2018)[53]	China	Neuromuscular Electrical Stimulation (NMES)	1hr/day 4 week consists 20 session	Pain, motor function	Therapeutic efficacy of NMES is superior to that of TENS in pain reduction but no significant improvement in motor function.

Noha et al., (2019)[64]	Korea	Repetitive Transcranial magnetic stimulation (rTMS) and action observation therapy (AO) along with conventional physiotherapy and occupational therapy rTMS along with conventional physiotherapy and occupational therapy	1 Hz, 20 minutes daily, 10 days. 2 minutes long, 20 minutes daily, 10 days. 1 hour twice a day, 5days/week	Both groups demonstrated significant gains in upper extremity functional parameters.	Both groups demonstrated significant gains in upper extremity functional parameters.
Zheng et al., (2019)[67]	China	Contralaterally controlled functional Stimulation(CCFES)+PNF	Two 20 minutes every day + 48 15-s sets, separeted by 10s of rest	Motor function	CCFES significantly shortened the time for regaining wrist dorsiflexion and improve function and general health of patients with early-phase stroke
Chen et al., (2020)[69]	China	FMS (functional magnetic stimulation)	10 sessions over 2 weeks.	Motor function	FMS improves paretic upper extremity function and leads to better recovery of motor activity than LF-rTMS
Straudi et al., (2019)[75]	Italy	Functional electrical stimulation (FES)+ Robotic Arm Training (RAT) intensive convention therapy	1 hr and 40 min 5times per week in 6 weeks	Motor function	Both groups equally improved their arm 213 impairment, arm function and activities of daily living
Jung et al., (2020)[78]	South Korea	ENFOS-MT(EMG triggered FES with MT)	30-minute sessions, 2/day, 5 days/week, for 6 weeks	Muscle strength, Motor function	EMFES-MT was more effective on elbow, WFMS, WEMS, AROM, grip strength and upper extremity function in patients with chronic stroke
Mano et al., (2021)[83]	Spain	Neuromuscular electrical stimulation	20 mins for the first session and 30 mins subsequent sessions	Motor function	NMES protocol proved evidence of improvement in measurements related to hand motor recovery

Zhuang et al., (2021)[84]	China	Associated Mirror Therapy	four weeks, five days/week, and around four hours/day.four weeks, five days/week, and around four hours/day	Motor function	The study demonstrates that AMT is a feasible and effective method to improve motor impairment of the paretic arm, enhance daily function, and may increase the ability of manual dexterity after stroke
Junqinn du et al., (2021)[87]	china	Neuromuscular electrical stimulation	30 min/day 5 day in week in 4 weeks	upper limb function	Patients improved their active workspace in the transverse plane but with no significant difference between the groups.
Jiang et al., (2022)[88]	China	Repetitive Peripheral Magnetic Stimulation in addition to conventional physiotherapy	20 mins each time, once a day, for 14 consecutive days	Motor function	In patients with no functional arm movement, rPMS of upper limb extensors improves arm function and muscle strength for grip and elbow flexion and extension.
Zhao et al., (2022)[90]	China	tDCS and smart hand joint training device group Smart hand joint training device group	Once per day, 6 days /week ,for 2 weeks	Motor function	Both smart hand joint training device alone and tDSC combined with the smart hand joint training device can improve hand function of patients with early stroke to varying degrees, but treatment effects of tDCS combined the smart hand joint training device is more significant
Yang et al., (2022) [91]	china	functional electrical stimulation (FES) + mirror therapy (MT)	20 minutes/day, 5 days/week, for 4 weeks	sensory motor cortex	FES+MT training method has obvious activation effect on the cerebral sensorimotor cortex

Table-06: Virtual reality, Gaming or Robotic therapy for improvement of upper limb motor function of stroke survivors

Author	Setting	Intervention	Dose	Outcome	Remarks
Cameirao et al., (2012)[2]	Barcelona	Rehabilitation Gaming system (RGS)-Exoskeleton(E) RGS-Haptics(H)	5d/week for 35 min/daily	Hand function	Both was effective in improving arm function than RGS only.
Liao et al., (2012)[7]	Taiwan	Bi-Manu-Track robotic arm, functional activity training	90-105 minutes a day, five days a week for four weeks. 15 minutes a day five days a week for four weeks	Hand function	Arm movements in the robot assisted therapy group significantly improved compared with the active control group.
Reinkensmeyer et al., (2012)[10]	United States	Three-dimensional assist as needed Robotic arm/hand movement training provided with Pneu-WREX	30 mins crossover, 3hrs/wk, 24 sessions at 3 month follow up	Hand function	This study suggest that the Three-dimensional virtual task with an Assist-As-Needed Robotic Training is more effective than Conventional Tabletop Training.
Friedman et al., (2014) [19]	USA	music glove strectching,ROM exercise, isometric	45 min session 3 times per week	Hand impairment	Engage & incorporate high number of repitation for gripping and opposition movement with afferent input that manipulate small hand movement

Hesse et al., (2014) [20]	germany	Robot assisted arm group therapy (RAGT)	30 minutes/ every workday/ 4 week	Arm function	All the treatment is equally effective
Lee & kim, (2016)[34]	Korea	Patients in the VRBT group performed bilateral upper extremity exercises in a virtual reality environment	30 minutes day1, 3 days a week, for a period of 6 week	upper extremity function	VRBT group showed statistically significant changes in JHFT
Espina et al., (2016)[35]	Mexico	Robot active assisted therapy	40 sessions ensuring at least 300 repetitions per sessions	Hand function and strength	Bigger effect size for robotic intervention in subacute stage of stroke.
Zondervan et al., (2016)[36]	Italy	Passive mobilization of the upper limb by robotic device ARMEO Spring along with Conventional physiotherapy	30 min/session, 5d/wk, 6 weeks	Pain, Disability, Spasticity	Robot assisted therapy was found to be more effective than passive range of motion exercise
Zondervan et al., (2016)[37]	USA	Music Glove	3hr/wk, 3 sessions/week	Hand grip function	Music Glove therapy is more effective than conventional therapy in terms of home based rehabilitation.
Barker et al., (2017)[39]	Australia	SMART Arm with OT-stim and usual therapy SMART Arm and usual therapy	60 min/day, 5 day/wk, 4 weeks	Hand function	All groups demonstrated significant arm improvement but no significant difference in improvement
Brunner et al., (2017)[40]	Europe	Virtual reality training CT	60 min/session, 16 sessions, 4 weeks	Hand function	VR may constitute a motivating training alternative as a supplement to standard rehabilitation

Capone et al., (2017)[41]	Italy	Real transcutaneous stimulation of the vagus nerve(tVNS) along with Robot assisted therapy	10 working days	upper limb function	tVNS is safe and its effectiveness can be enhanced by robotic assistance
Constantino, Galippo & Romiti., (2016)[43]	Italy	Muscle vibration	30 minutes 3 times per week, for 12 sessions,	Griping muscle strength, Tone	The mirror illusion induced by MT may be utilized for sensory and motor deficits as well as for the more affected and less affected hands.
Rowe et al., (2017)[47]	USA	Robot assisted therapy	3 h/wk for 3 weeks		High-assistance training was more effective for participants with more severe motor impairments.
Tijana et al., (2016)[48]	Serbia	Arm assisted robotic training	30 min per day 5 days in week in 3 weeks	Upper limb function	Comparably greater reduction in the upper limb motor impairment
Askin et al., (2018)[49]	Turkey	VR therapy	5days/week for 4 week	Upper limb function	Although both groups benefited from rehabilitative procedures to some extent, Kinect based VR training seemed to contribute more to the improvement of motor function and AROM of affected upper limbs in chronic stroke patients.
Amft et al., (2018)[55]	Switzerland	VR based training Conventional physiotherapy	16x45 minutes for 4 weeks	UE motor function	Both group Showed similar effects, most improvement occuring in the first two weeks until the end of the two month follow-up period

Villafane et al., (2018)[56]	Italy	Robotic therapy	1 hour,5days/weeks for 3 weeks	Motor function	The robotic assisted treatment may contribute towards the recovery of hand motor function in acute stroke patients and it is safe and reliable.
Annino Et Al., (2019)[57]	Italy	muscle vibration	3 sessions per week of SPT for 8 weeks	upper limb function	The SPT intervention can improve functional outcomes of upper extremity in people after stroke. However, using SMV may have superior effect on improving muscle tone after stroke.
Conroy et al., (2019)[59]	USA	Robot-assisted interventions	1 hour, 3 times a week, over a 12-week period for a maximum of 36 visits.	Upper limb motor function	Chronic UE motor deficits are responsive to intensive robot-assisted therapy of 45 or 60 minutes per session duration. The replacement of part of the robotic training with nonrobotic tasks did not reduce treatment effect and may benefit stroke-affected hand use and motor task performance.
Dehem et al., (2019)[60]	Belgium	Robot assisted therapy (RAT)	45 min/session, 36 RAT sessions in total (4 sessions/week over 9 weeks)		For the same duration of daily rehabilitation, RAT combined with conventional therapy during the early rehabilitation phase after stroke is more effective than conventional therapy alone

					to improve gross manual dexterity, upper-limb ability during functional tasks and patient social participation.
Henrique et a., (2019)l[61]	Brazil	Motion Rehab AVE 3D	twice a week, for 30 minutes each, over a 12-week period, resulting in 24 sessions	Balance, Motor function	………
Rodgers et al., (2019)[66]	UK	Robotic assisted training Enhanced Upperlimb therapy Supervised usual therapy	45 min 3 times/week for 12 weeks	Motor function	No significant differences among groups, all groups improved motor function
Rodgers et al., (2020)[71]	UK	Robot assisted therapy	45 minutes 3 days/week for 12 weeks.	Motor function	Robot-assisted training using the Massachusetts Institute of Technology-Manus robotic gym improved upper limb function after a stroke when compared with an enhanced upper limb therapy programme
Chang et al., (2021)[76]	Chicago	Active Transcutaneous auricular branch vagus nerve stimulator (taVNS)+ robotic training	500 ms bursts, frequency 30 HZ, pulse width 0.3 ms, max intensity 5mA	Spasticity, Muscle power	Upper limb robotic training combined with taVNS delivered selectively during extension movements demonstrated significant reductions in spasticity at the wrist and hand and significant changes in bicep EMG peak amplitude during extension movements

Kafi et al., (2021)[77]	Saudi Arabia	Conventional functional training program + virtual reality-based therapy	1+1 hour ,3x/week for 3 months	Motor function	After 3 month,individual with stroke in experimental group had a better improvement in ARAT,WMFT and WMFT-Time scores after completion of the treatment compared to control group
Llorens et al., (2021)[80]	Spain	Transcutaneous direct current stimulation(tDCS) & VR based therapy	25 one-hour sessions, 3-5 times a week	Sensory and motor function	tDCS and VR based therapy improves the motor & sensory function when compared to conventional physical therapy alone
Widmer et al., (2022)[85]	Switzerland	Armeo Senso arm rehabilitation system along with visual and auditory feedback	1 hr per day, 5 days a week, 3 weeks	Motor function	Patients improved their active workspace in the transverse plane but with no significant difference between the groups.
Chen et al., (2022)[86]	China	ArmeoS enso arm rehabilitation system along with visual and auditory feedback	1 hr per day, 5 days a week, 3 weeks	motor function	the study demonstrates that AMT is a feasible and effective method to improve motor impairment of the paretic arm, enhance daily function, and may increase the ability of manual dexterity after stroke.

Table-07: Combination of multiple therapeutic intervention for upper limb motor function of stroke survivors

Author	**Setting**	**Intervention**	**Dose**	**Outcome**	**Remarks**
Carolina, Noe & Llorens, (2016)[31]	Spain	Mirror therapy Mobilization	1hr/day, 5 days/week, 24 sessions	Motor and sensory function	Both show similar results
Annino et al., (2019)[57]	italy	muscle vibration	3 sessions per week of SPT for 8 weeks	upper limb function	The SPT intervention can improve functional outcomes of upper extremity in people after stroke. However, using SMV may have superior effect on improving muscle tone after stroke.
Qian et a., (2019)l[65]	Hong Kong	Neuromuscular Electrical Stimulation(NMES)-robotic sleeve-assisted training	3-5 session /week, at most 1 session /day, within 7 consecutive weeks	Motor function, Spasticity	The robotic support directly to the distal finger was more effective than to the proximal parts in improving motor functions and in releasing muscle spasticity in the whole upper extremity
Caitlyn et al., (2021)[82]	Georgia	Transcutaneous direct current stimulation(tDCS) & VR based therapy	25 one-hour sessions, 3-5 times a week	motor and sensory function	tDCS, improves the motor & sensory function when compared to conventional physical therapy alone

Table-08: Home exercise/advice for improvement of upper limb motor function of stroke survivors

Author	Setting	Intervention	Dose	Outcome	Remarks
Wolf et al., (2015)[30]	USA	Combined home exercise programe and hand mentor pro	3 hr/day	upper limb motor function	There was no difference between groups in changing motor function over time

CHAPTER-V: DISCUSSION

This review has highlighted that there are large number of randomized controlled trials of clearly described hands-on therapeutic interventions for the upper limb motor recovery of stroke patient. Furthermore, of those identified, all have limitations in terms of methodological quality. A total of 91 studies selected and reviewed systematically for relevance and quality with regards to upper extremity motor outcome. Physiotherapy interventions were divided into six different chapters, as well as discussed and recommended on the basis of current scientific evidence. The review itself has clear strengths in that it used a wide search strategy. A large amount of the searches was computer-generated. The main findings of this multiple systematic review concerning rehabilitation techniques focusing on the UE motor outcome, may be summarized as follows:

Physiotherapy interventions recommended on the basis of current evidence for pain, spasticity and improving UE motor recovery, are: Exercise therapy (CIMT, modified CIMT, task-oriented movement, volleyball exercise, motor relearning programme, mirror therapy, task-based mirror therapy), Manual therapy (Bobath, Passive joint mobilization), Electrotherapy (FES, CCFES, NMES, rTMS), Virtual reality, gaming or robotic therapy and home-based exercise.

Among the 91 studies the suggested dose for exercise therapy were minimum 20 mins to maximum120 mins/session (Average: 60 mins) for 3 to 6 days/week (Average 3 days) and continued for 2 to 10 weeks (Average: 5 weeks). Manual therapy was administered from 25 to 120 minutes per session for 10 to 8 weeks (mean: 4 weeks). Electrotherapies were administered for 20 to 60 minutes (mean 30 minutes) per session, for a minimum of two weeks and a maximum of twelve weeks. In the case of gaming and virtual reality, the administered dosages lasted between 20 minutes and one hour and lasted between 10 days and three months. The average rehabilitation program was conducted five days per week. The experimental group demonstrated effectiveness in the majority of the investigation.

Motor imagery (impairments and disabilities), high frequency-transcutaneous electrical nerve stimulation (impairments and disabilities), passive neuromuscular electrical stimulation (impairments), repetitive transcranial magnetic stimulation (impairments), and transcranial direct current stimulation (impairments) are recommended as an adjuvant therapy (combined with another rehabilitation treatment) for improving UE motor outcome, based on current evidence.

Depending on the stage of stroke, certain rehabilitation strategies may be more suitable than others. The following rehabilitation techniques have been studied and are recommended for acute stroke patients: muscle strengthening exercises, constraint-induced movement therapy (at a lower dosage), mirror therapy, passive neuromuscular electrical stimulation, repetitive transcranial magnetic stimulation, and transcranial direct current stimulation. The following rehabilitation techniques have been studied and are recommended for subacute stroke patients: muscle strengthening exercises, constraint-induced movement, mirror therapy, mental practice with motor imagery, high frequency-transcutaneous electrical nerve stimulation, passive neuromuscular electrical stimulation, repetitive transcranial magnetic stimulation, and transcranial direct current stimulation. The following rehabilitation techniques have been studied and recommended for chronic stroke patients: muscle strengthening exercises, constraint-induced movement therapy, mirror therapy, mental practice with motor imagery, high frequency-transcutaneous electrical nerve stimulation, repetitive transcranial magnetic stimulation, transcranial direct current stimulation, and virtual reality.

Currently, it reflects how scientific data should undergird the stroke rehabilitation strategy and how physiotherapy interventions can be chosen according to dose based on the characteristics of the individual patient. A patient may be excluded from the proposed treatment strategy for particular reasons.

Overall, the findings of this systematic review indicated that goal-specific training and routine arm and hand use positively influence the functional recovery of stroke patients. Task-oriented training optimizes UE motor function in relation to the targeted motor task ("you gain what you train"), but subsequent improvements in motor impairment do not transfer to improvements in motor disabilities in activities of daily living. Contrast, for instance, the ineffectiveness of bilateral arm training (non-goal-oriented repetitive task movements) with the significant improvement of motor impairments and disabilities by constraint-induced movement therapy employing goal-oriented motor skill learning principles. Virtual reality, gaming or robotic therapy showed greater improvement in upper limb motor recovery than other therapeutic interventions.

A functional bimanual intensive training without constraint (as described in children with congenital hemiplegia by Charles and Gordon, 2006; Gordon et al., 2007) could be a future research direction for adult stroke neurorehabilitation. It also appears that the impact of rehabilitation technology on functional outcome could be enhanced by providing the nervous system with more opportunities to experience "real" and repetitive activity-related adequate sensory-motor input during upper limb movement training, as opposed to task-specific exercises.

In conclusion, numerous clinical and research interventions exist to improve the motor function of the upper extremities in stroke patients. Moreover, interventions can be combined to obtain the maximum recovery of motor function for each patient. Various rehabilitation approaches appear to ameliorate severe upper limb impairments and disability in the subacute phase after stroke; however, they are not significantly superior to standard care or other interventions administered at the same dose. Robotic therapy and functional electrical stimulation offer variety to rehabilitation programs, but their superiority to standard care has not been demonstrated. The impact of dosage parameters (e.g., intensity) on severe upper limb motor impairments and function, particularly in the acute phase, requires additional study. Although the efficacy of some interventions is debatable, specific rehabilitation approaches provide a positive outlook for motor recovery in the upper extremity after stroke.

CHAPTER-VI CONCLUSION

The current difficulty in upper limb stroke rehabilitation is balancing the demands of each individual patient through individualized therapeutic interventions. This review included only randomized controlled studies and their experimental outcomes were also included to examine their efficacies and usability. It has been hypothesized that the intervention dosages and effectiveness mostly depend on the intervention categories, severity, pattern and duration of the stroke. There is a significant numbers of evidence regarding the effectiveness of physiotherapy for UL motor recovery of stroke, but it is not yet clear whether combined or conventional therapy, mirror therapy or electrical stimulation alone are more likely for the expected outcome. However, the overall results showed that physical therapy-based rehabilitation training during the recovery period of stroke patients improves upper limb motor activity by increases muscle strength, reduces limb pain and improves the quality of life. Majority of the studies supported that the interventions at different doses are more effective rather than the conventional only. The effects and the doses of individual intervention are still under debate, but with appropriate investment in upper limb stroke recovery research, we can build a clear rationale for the selection of timing, dose and intervention type for poststroke.

Hence, further research and also meta-analysis should focus on a more precise prediction of the level of motor recovery after stroke based on physical characteristics, type, size, and site of the lesion.

CHAPTER-VII REFERENCE

- Addo, J., Ayerbe, L., Mohan, K. M., Crichton, S., Sheldenkar, A., Chen, R. & McKevitt, C. (2012). Socioeconomic status and stroke: an updated review. *Stroke*, *43*(4), 1186-1191.
- Alashram, A. R., Alghwiri, A. A., Padua, E. & Annino, G. (2021). Efficacy of proprioceptive neuromuscular facilitation on spasticity in patients with stroke: A systematic review. *Physical Therapy Reviews*, *26*(3), 168-176.
- Bandura, A. (1997). The nature and structure of self-efficacy. *Self-efficacy: the exercise of control. New York: Freeman and Company*, 37-78.
- Bangash, A. H. (2022). Mesenchymal stem-cells therapy for ischemic stroke patients: Protocol for systematic review & meta-analysis of randomized-controlled trials. *Alexmede Posters*, *3*(3), 13-14.
- Bernhardt, J., Borschmann, K., Boyd, L., Carmichael, S. T., Corbett, D., Cramer, S. C. & Ward, N. (2017). Moving rehabilitation research forward: developing consensus statements for rehabilitation and recovery research. *Neurorehabilitation and neural repair*, *31*(8), 694-698.
- Bernhardt, J., Hayward, K. S., Kwakkel, G., Ward, N. S., Wolf, S. L., Borschmann, K. & Cramer, S. C. (2017). Agreed definitions and a shared vision for new standards in stroke recovery research: the stroke recovery and rehabilitation roundtable taskforce. *Journal of Neurorehabilitation and neural repair*, *31*(9), 793-799.
- Bhakta, B. B. (2000). Management of spasticity in stroke. *British medical bulletin*, *56*(2), 476-485.
- Boake, C., Noser, E. A., Ro, T., Baraniuk, S., Gaber, M., Johnson, R. & Levin, H. S. (2007). Constraint-induced movement therapy during early stroke rehabilitation. *Neurorehabilitation and neural repair*, *21*(1), 14-24.
- Buma, F., Kwakkel, G. & Ramsey, N. (2013). Understanding upper limb recovery after stroke. *Restorative neurology and neuroscience*, *31*(6), 707-722.

- Bunketorp-Käll, L., Lundgren-Nilsson, A., Samuelsson, H., Pekny, T., Blomve, K., Pekna, M. & Nilsson, M. (2017). Long-term improvements after multimodal rehabilitation in late phase after stroke: a randomized controlled trial. *Stroke*, *48*(7), 1916-1924.
- Burdea, G. C., Cioi, D., Martin, J., Fensterheim, D. & Holenski, M. (2010). The Rutgers Arm II rehabilitation system—a feasibility study. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, *18*(5), 505-514.
- Buschfort, R., Brocke, J., Hess, A., Werner, C., Waldner, A. & Hesse, S. (2010). Arm studio to intensify the upper limb rehabilitation after stroke: concept, acceptance, utilization and preliminary clinical results. *Journal of rehabilitation medicine*, *42*(4), 310-314.
- Bustamante Valles, K., Montes, S., Madrigal, M. D. J., Burciaga, A., Martínez, M. E. & Johnson, M. J. (2016). Technology-assisted stroke rehabilitation in Mexico: a pilot randomized trial comparing traditional therapy to circuit training in a robot/technology-assisted therapy gym. *Journal of neuroengineering and rehabilitation*, *13*(1), 1-15.
- Bustamante Valles, K., Montes, S., Madrigal, M. D. J., Burciaga, A., Martínez, M. E. & Johnson, M. J. (2016). Technology-assisted stroke rehabilitation in Mexico: a pilot randomized trial comparing traditional therapy to circuit training in a robot /technology-assisted therapy gym. *Journal of neuroengineering and rehabilitation*, *13*(1), 1-15.
- Camona, C., Wilkins, K. B., Drogos, J., Sullivan, J. E., Dewald, J. P. & Yao, J. (2018). Improving hand function of severely impaired chronic hemiparetic stroke individuals using task-specific training with the ReIn-Hand system: A case series. *Frontiers in neurology*, *9*, 923.
- Carod-Artal, F. J. & Egido, J. A. (2009). Quality of life after stroke: the importance of a good recovery. *Cerebrovascular diseases*, *27*(Suppl. 1), 204-214.
- Casaubon, L. K., Boulanger, J. M., Blacquiere, D., Boucher, S., Brown, K., Goddard, T. & Lindsay, P. (2015). Canadian stroke best practice recommendations: hyperacute stroke care guidelines, update 2015. *International journal of stroke*, *10*(6), 924-940.

- Casaubon, L. K., Boulanger, J. M., Glasser, E., Blacquiere, D., Boucher, S., Brown, K. & Lindsay, P. (2016). Canadian stroke best practice recommendations: acute inpatient stroke care guidelines, update 2015. *International Journal of Stroke*, *11*(2), 239-252.
- Chuang, L. L., Wu, C. Y. & Lin, K. C. (2012). Reliability, validity, and responsiveness of myotonometric measurement of muscle tone, elasticity, and stiffness in patients with stroke. *Archives of physical medicine and rehabilitation*, *93*(3), 532-540.
- Cirstea, C. M., Ptito, A. & Levin, M. F. (2006). Feedback and cognition in arm motor skill reacquisition after stroke. *Stroke*, *37*(5), 1237-1242.
- Connell, L., McMahon, N., Eng, J. & Watkins, C. L. (2014). Prescribing upper limb exercises after stroke: a survey of current UK therapy practice. *Journal of Rehabilitation Medicine*, *46*(3), 212-218.
- Cooke, E. V., Mares, K., Clark, A., Tallis, R. C. & Pomeroy, V. M. (2010). The effects of increased dose of exercise-based therapies to enhance motor recovery after stroke: a systematic review and meta-analysis. *BMC medicine*, *8*(1), 1-13.
- Coutts, S. B., Wein, T. H., Lindsay, M. P., Buck, B., Cote, R., Ellis, P. & Gubitz, G. (2015). Canadian Stroke Best Practice Recommendations: secondary prevention of stroke guidelines, update 2014. *International journal of stroke*, *10*(3), 282-291.
- Craig, L. E., McInnes, E., Taylor, N., Grimley, R., Cadilhac, D. A., Considine, J. & Middleton, S. (2016). Identifying the barriers and enablers for a triage, treatment, and transfer clinical intervention to manage acute stroke patients in the emergency department: a systematic review using the theoretical domains framework (TDF). *Implementation Science*, *11*(1), 1-18.
- Cumming, T. B., Brodtmann, A., Darby, D. & Bernhardt, J. (2014). The importance of cognition to quality of life after stroke. *Journal of psychosomatic research*, *77*(5), 374-379.

- Divya, M. & Narkeesh, A. (2022). Therapeutic Effect of Multi-Channel Transcranial Direct Current Stimulation (M-tDCS) on Recovery of Cognitive Domains, Motor Functions of Paretic Hand and Gait in Subacute Stroke Survivors-A Randomized Controlled Trial Protocol. *Neuroscience Insights*, *17*, 26331055221087741.
- Ellepola, S., Nadeesha, N., Jayawickrama, I., Wijesundara, A., Karunathilaka, N. & Jayasekara, P. (2022). Quality of life and physical activities of daily living among stroke survivors; cross‐sectional study. *Nursing Open*, *9*(3), 1635-1642.
- Elshaikh, M. Y. (2021). Detection of neuron specific enolase asa diagnostic biomarker and its correlation to functional neurological outcome in acute ischemic stroke. *Alexmede Posters*, *3*(3), 13-14.
- Eng, X. W., Brauer, S. G., Kuys, S. S., Lord, M. & Hayward, K. S. (2014). Factors affecting the ability of the stroke survivor to drive their own recovery outside of therapy during inpatient stroke rehabilitation. *Stroke research and treatment*, *2014*.
- Eskes, G. A., Lanctot, K. L., Herrmann, N., Lindsay, P., Bayley, M., Bouvier, L. & Swartz, R. H. (2015). Canadian stroke best practice recommendations: mood, cognition and fatigue following stroke practice guidelines, update 2015. *International Journal of Stroke*, *10* (7), 1130-1140.
- Faria-Fortini, I., Michaelsen, S. M., Cassiano, J. G. & Teixeira-Salmela, L. F. (2011). Upper extremity function in stroke subjects: relationships between the international classification of functioning, disability, and health domains. *Journal of Hand Therapy*, *24*(3), 257-265.
- Feigin, V. L., Brainin, M., Norrving, B., Martins, S., Sacco, R. L., Hacke, W. & Lindsay, P. (2022). World Stroke Organization (WSO): global stroke fact sheet 2022. *International Journal of Stroke*, *17*(1), 18-29.
- Feigin, V. L., Lawes, C. M., Bennett, D. A., Barker-Collo, S. L. & Parag, V. (2009). Worldwide stroke incidence and early case fatality reported in 56 population-based studies: a systematic review. *The Lancet Neurology*, *8*(4), 355-369.

- Feigin, V. L., Stark, B. A., Johnson, C. O., Roth, G. A., Bisignano, C., Abady, G. G. & Hamidi, S. (2021). Global, regional, and national burden of stroke and its risk factors, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet Neurology*, *20*(10), 795-820.
- Feigin, V. L., Stark, B. A., Johnson, C. O., Roth, G. A., Bisignano, C., Abady, G. G. & Hamidi, S. (2021). Global, regional, and national burden of stroke and its risk factors, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet Neurology*, *20*(10), 795-820.
- French, B., Thomas, L. H., Leathley, M. J., Sutton, C. J., McAdam, J., Forster, A. & Watkins, C. L. (2010). Does repetitive task training improve functional activity after stroke? A Cochrane systematic review and meta-analysis. *Journal of rehabilitation medicine: official journal of the UEMS European Board of Physical and Rehabilitation Medicine*, *42*(1), 9-14.
- Frost, L. J. & Reich, M. R. (2009). Creating access to health technologies in poor countries. *Health Affairs*, *28*(4), 962-973.
- Galvin, R., Murphy, B., Cusack, T.& Stokes, E. (2008). The impact of increased duration of exercise therapy on functional recovery following stroke—what is the evidence?. *Topics in Stroke Rehabilitation*, *15*(4), 365-377.
- Gracies, J. M., Pradines, M., Ghédira, M., Loche, C. M., Mardale, V., Hennegrave, C. & Bayle, N. (2019). Guided Self-rehabilitation Contract vs conventional therapy in chronic stroke-induced hemiparesis: NEURORESTORE, a multicenter randomized controlled trial. *Bio Med Central neurology Journal*, *19*(1), 1-11.
- Gresham, G. E., Stason, W. B. & Duncan, P. W. (2004). *Post-stroke rehabilitation* (Vol. 95, No. 662). Diane Publishing.
- Grimshaw, J., Thomas, R., MacLennan, G., Fraser, C. R. R. C., Ramsay, C. R., Vale, L. E. E. A. & Donaldson, C. (2004). Effectiveness and efficiency of guideline dissemination and implementation strategies.

- Hamilton, C., Lovarini, M., McCluskey, A., Folly de Campos, T. & Hassett, L. (2019). Experiences of therapists using feedback-based technology to improve physical function in rehabilitation settings: a qualitative systematic review. *Disability and Rehabilitation*, *41*(15), 1739-1750.
- Han, C. E., Kim, S., Chen, S., Lai, Y. H., Lee, J. Y., Osu, R. & Schweighofer, N. (2013). Quantifying arm nonuse in individuals poststroke. *Neurorehabilitation and neural repair*, *27*(5), 439-447.
- Harris, J. E. & Eng, J. J. (2006). Individuals with the dominant hand affected following stroke demonstrate less impairment than those with the nondominant hand affected. *Neurorehabilitation and neural repair*, *20*(3), 380-389.
- Hayward, K. S. & Brauer, S. G. (2015). Dose of arm activity training during acute and subacute rehabilitation post stroke: a systematic review of the literature. *Clinical rehabilitation*, *29*(12), 1234-1243.
- Hebert, D., Lindsay, M. P., McIntyre, A., Kirton, A., Rumney, P. G., Bagg, S. & Teasell, R. (2016). Canadian stroke best practice recommendations: stroke rehabilitation practice guidelines, update 2015. *International Journal of Stroke*, *11*(4), 459-484.
- Hegedus, B. (2018). The potential role of thermography in determining the efficacy of stroke rehabilitation. *Journal of Stroke and Cerebrovascular Diseases*, *27*(2), 309-314.
- Isuru, A., Hapangama, A., Ediriweera, D., Samarasinghe, L., Fonseka, M. & Ranawaka, U. (2021). Prevalence and predictors of new onset depression in the acute phase of stroke. *Asian journal of Psychiatry*, *59*, 102636.
- Johnson, C. O., Nguyen, M., Roth, G. A., Nichols, E., Alam, T., Abate, D. & Miller, T. R. (2019). Global, regional, and national burden of stroke, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Neurology*, *18*(5), 439-458.
- Jolliffe, L., Lannin, N. A., Cadilhac, D. A. & Hoffmann, T. (2018). Systematic review of clinical practice guidelines to identify recommendations for rehabilitation after stroke and other acquired brain injuries. *British Medical Journal open*, *8*(2), 018791.

- Jones, S. P., Baqai, K., Clegg, A., Georgiou, R., Harris, C., Holland, E. J. & Hackett, M. L. (2022). Stroke in India: A systematic review of the incidence, prevalence, and case fatality. *International Journal of Stroke*, *17*(2), 132-140.
- Kara, S. & Ntsiea, M. V. (2015). The effect of a written and pictorial home exercise prescription on adherence for people with stroke. *Hong Kong Journal of Occupational Therapy*, *26*, 33-41.
- Kılınç, M., Avcu, F., Onursal, O., Ayvat, E., SavcunDemirci, C. & Aksu Yildirim, S. (2016). The effects of Bobath-based trunk exercises on trunk control, functional capacity, balance, and gait: a pilot randomized controlled trial. *Topics in stroke rehabilitation*, *23*(1), 50-58.
- Kim, R. K. & Kang, N. (2020). Bimanual coordination functions between paretic and nonparetic arms: a systematic review and meta-analysis. *Journal of Stroke and Cerebrovascular Diseases*, *29*(2), 104544.
- Kiper, P., Turolla, A., Piron, L., Agostini, M., Baba, A., Rossi, S. & Tonin, P. (2010). Virtual reality for stroke rehabilitation: assessment, training and the effect of virtual therapy. *Medical Rehabilitation*, *14*, 23-32.
- Knutson, J. S., Hisel, T. Z., Harley, M. Y. & Chae, J. (2009). A novel functional electrical stimulation treatment for recovery of hand function in hemiplegia: 12-week pilot study. *Neurorehabilitation and neural repair*, *23*(1), 17-25.
- Korpershoek, C., Van der Bijl, J. & Hafsteinsdóttir, T. B. (2011). Self‐efficacy and its influence on recovery of patients with stroke: a systematic review. *Journal of advanced nursing*, *67*(9), 1876-1894.
- Krishnamurthi, R. V., Ikeda, T. & Feigin, V. L. (2020). Global, regional and country-specific burden of ischaemic stroke, intracerebral haemorrhage and subarachnoid haemorrhage: a systematic analysis of the global burden of disease study 2017. *Neuroepidemiology*, *54*(2), 171-179.
- Kumar, S. & Yadav, R. (2020). Comparison between Erigo tilt-table exercise and conventional physiotherapy exercises in acute stroke patients: a randomized trial. *Archives of physiotherapy*, *10*(1), 1-9.

- Kuzu, O., Adiguzel, E., Kesikburun, S., Yaşar, E. & Yılmaz, B. (2021). The effect of sham controlled continuous theta burst stimulation and low frequency repetitive transcranial magnetic stimulation on upper extremity spasticity and functional recovery in chronic ischemic stroke patients. *Journal of Stroke and Cerebrovascular Diseases*, *30*(7), 105795.
- Kwakkel, G., Kollen, B. J. & Krebs, H. I. (2008). Effects of robot-assisted therapy on upper limb recovery after stroke: a systematic review. *Neurorehabilitation and neural repair*, *22*(2), 111-121.
- Lai, C. H., Sung, W. H., Chiang, S. L., Lu, L. H., Lin, C. H., Tung, Y. C. & Lin, C. H. (2019). Bimanual coordination deficits in hands following stroke and their relationship with motor and functional performance. *Journal of neuroengineering and rehabilitation*, *16*(1), 1-14.
- Lai, S. M., Studenski, S., Duncan, P. W. & Perera, S. (2002). Persisting consequences of stroke measured by the Stroke Impact Scale. *Stroke Journal*, *33*(7), 1840-1844.
- Laufer, Y. & Elboim-Gabyzon, M. (2011). Does sensory transcutaneous electrical stimulation enhance motor recovery following a stroke? A systematic review. *Neurorehabilitation and neural repair*, *25*(9), 799-809.
- Lee, S., Kim, Y. & Lee, B. H. (2016). Effect of virtual reality-based bilateral upper extremity training on upper extremity function after stroke: a randomized controlled clinical trial. *Occupational therapy international*, *23*(4), 357-368.
- Lynch, E., Hillier, S. & Cadilhac, D. (2014). When should physical rehabilitation commence after stroke: a systematic review. *International Journal of Stroke*, *9*(4), 468-478.
- Maredza, M., Bertram, M. Y. & Tollman, S. M. (2015). Disease burden of stroke in rural South Africa: an estimate of incidence, mortality and disability adjusted life years. *Boston Medical Centre neurology*, *15*(1), 1-12.
- Mathieson, S., Parsons, J. & Kaplan, M. S. (2014). Combining functional electrical stimulation with mirror therapy for the upper limb in people with stroke. *Critical Reviews™ in Physical and Rehabilitation Medicine*, *26*(1-2).

- McNulty, P. A., Thompson-Butel, A. G., Faux, S. G., Lin, G., Katrak, P. H., Harris, L. R. & Shiner, C. T. (2015). The efficacy of Wii-based Movement Therapy for upper limb rehabilitation in the chronic poststroke period: a randomized controlled trial. *International Journal of Stroke*, *10*(8), 1253-1260.
- Menon, A., Korner-Bitensky, N., Kastner, M., McKibbon, K. A. & Straus, S. (2009). Strategies for rehabilitation professionals to move evidence-based knowledge into practice: a systematic review. *Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews [Internet]*.
- Merians, A. S., Poizner, H., Boian, R., Burdea, G. & Adamovich, S. (2006). Sensorimotor training in a virtual reality environment: does it improve functional recovery post-stroke? *Neurorehabilitation and neural repair*, *20*(2), 252-267.
- Meyer, S., Karttunen, A. H., Thijs, V., Feys, H. & Verheyden, G. (2014). How do somatosensory deficits in the arm and hand relate to upper limb impairment, activity, and participation problems after stroke? A systematic review. *Physical therapy*, *94*(9), 1220-1231.
- Michie, S. & Abraham, C. (2004). Interventions to change health behaviours: evidence-based or evidence-inspired?. *Psychology & Health*, *19*(1), 29-49.
- Mondal, M. B. A., Hasan, A. H., Khan, N. & Mohammad, Q. D. (2022). Prevalence and risk factors of stroke in Bangladesh: A nationwide population-based survey. *Eneurologicalsci*, *28*, 100414.
- Moullin, J. C., Sabater-Hernandez, D., Fernandez-Llimos, F. & Benrimoj, S. I. (2015). A systematic review of implementation frameworks of innovations in healthcare and resulting generic implementation framework. *Health research policy and systems*, *13*(1), 1-11.
- Murphy, T. H. & Corbett, D. (2009). Plasticity during stroke recovery: from synapse to behavior. *Nature reviews neuroscience*, *10*(12), 861-872.
- Ning, Y., Wang, H., Tian, J., Zhu, P., Yang, C. & Niu, J. (2022). Design, optimization, and analysis of a human-machine compatibility upper extremity exoskeleton rehabilitation robot. *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, 09544062221139988.

- Ntsiea, M. V. (2019). Current stroke rehabilitation services and physiotherapy research in South Africa. *South African Journal of Physiotherapy*, *75*(1), 1-10.
- Page, S. J., Levine, P. & Leonard, A. (2007). Mental practice in chronic stroke: results of a randomized, placebo-controlled trial. *Stroke Journal*, *38*(4), 1293-1297.
- Palumbo, A., Aluru, V., Battaglia, J., Geller, D., Turry, A., Ross, M. & Raghavan, P. (2022). Music Upper Limb Therapy–Integrated Provides a Feasible Enriched Environment and Reduces Post-stroke Depression: A Pilot Randomized Controlled Trial. *American Journal of Physical Medicine & Rehabilitation*, *101*(10): 937-946.
- Pandian, J. D., Kalkonde, Y., Sebastian, I. A., Felix, C., Urimubenshi, G. & Bosch, J. (2020). Stroke systems of care in low-income and middle-income countries: challenges and opportunities. *The Lancet*, *396*(10260), 1443-1451.
- Pang, M. Y., Harris, J. E., & Eng, J. J. (2006). A community-based upper-extremity group exercise program improves motor function and performance of functional activities in chronic stroke: a randomized controlled trial. *Archives of physical medicine and rehabilitation*, *87*(1), 1-9.
- Pasiga, B. D. & Dewi, C. (2019). The Effectiveness of the Use of" Special Grip Toothbrushes" on Dental Hygiene for Indonesian Patients with Ischemic Stroke. *Pesquisa Brasileiraem Odontopediatria Clínica Integrada*, *19*.
- Pekna, M., Pekny, M. & Nilsson, M. (2012). Modulation of neural plasticity as a basis for stroke rehabilitation. *Stroke Journal*, *43*(10), 2819-2828.
- Pollock, A., Baer, G., Campbell, P., Choo, P. L., Forster, A., Morris, J. & Langhorne, P. (2014). Physical rehabilitation approaches for the recovery of function and mobility following stroke. *Cochrane Database of Systematic Reviews*, (4).

- Pollock, A., Baer, G., Campbell, P., Choo, P. L., Forster, A., Morris, J. & Langhorne, P. (2014). Physical rehabilitation approaches for the recovery of function and mobility following stroke. *Cochrane Database of Systematic Reviews*, (4).

- Pollock, A., Farmer, S. E., Brady, M. C., Langhorne, P., Mead, G. E., Mehrholz, J. & van Wijck, F. (2014). Interventions for improving upper limb function after stroke. *Cochrane Database of Systematic Reviews*, (11).
- Pollock, K., Stroemer, P., Patel, S., Stevanato, L., Hope, A., Miljan, E. & Sinden, J. D. (2006). A conditionally immortal clonal stem cell line from human cortical neuroepithelium for the treatment of ischemic stroke. *Experimental neurology*, *199*(1), 143-155.
- Ranawaka, U. K. & Venketasubramanian, N. (2021). Stroke in Sri Lanka: how can we minimise the burden?. *Cerebrovascular diseases extra*, *11*(1), 46-48.
- Rand, D. & Eng, J. J. (2012). Disparity between functional recovery and daily use of the upper and lower extremities during subacute stroke rehabilitation. *Neurorehabilitation and neural repair*, *26*(1), 76-84.
- Rand, D. & Eng, J. J. (2015). Predicting daily use of the affected upper extremity 1 year after stroke. *Journal of Stroke and Cerebrovascular Diseases*, *24*(2), 274-283.
- Raphael, C. E., Roger, V. L., Sandoval, Y., Singh, M., Bell, M., Lerman, A. & Gulati, R. (2020). Incidence, trends, and outcomes of type 2 myocardial infarction in a community cohort. *Circulation*, *141*(6), 454-463.
- Rhoda, A., Smith, M., Putman, K., Mpofu, R., DeWeerdt, W. & DeWit, L. (2014). Motor and functional recovery after stroke: a comparison between rehabilitation settings in a developed versus a developing country. *BMC Health Services Research*, *14*(1), 1-7.
- Richards, L. G., Senesac, C. R., Davis, S. B., Woodbury, M. L. & Nadeau, S. E. (2008). Bilateral arm training with rhythmic auditory cueing in chronic stroke: not always efficacious. *Neurorehabilitation and neural repair*, *22*(2), 180-184.
- Roy, S. H., Cheng, M. S., Chang, S. S., Moore, J., De Luca, G., Nawab, S. H. & De Luca, C. J. (2009). A combined sEMG and accelerometer system for monitoring functional activity in stroke. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, *17*(6), 585-594.

- Saha, U. K., Alam, M. B., Rahman, A. K. M. F., Hussain, A. H. M. E., Mashreky, S. R., Mandal, G. & Mohammad, Q. D. (2018). Epidemiology of stroke: findings from a community-based survey in rural Bangladesh. *Public health*, *160*, 26-32.
- Saini, V., Guada, L. & Yavagal, D. R. (2021). Global epidemiology of stroke and access to acute ischemic stroke interventions. *Neurology*, *97*(20 Supplement 2), S6-S16.
- Salbach, N. M., Mountain, A., Lindsay, M. P., Blacquiere, D., McGuff, R., Foley, N. & Canadian Stroke Best Practice Recommendations Advisory Committee. (2022). Canadian stroke best practice recommendations: virtual stroke rehabilitation interim consensus statement 2022. *American Journal of Physical Medicine & Rehabilitation*, *101*(11), 1076-1082.
- Sasaki, K., Matsunaga, T., Tomite, T., Yoshikawa, T. & Shimada, Y. (2012). Effect of electrical stimulation therapy on upper extremity functional recovery and cerebral cortical changes in patients with chronic hemiplegia. *Biomedical Research*, *33*(2), 89-96.
- Schinwelski, M. J., Sitek, E. J., Wąz, P. & Sławek, J. W. (2019). Prevalence and predictors of post-stroke spasticity and its impact on daily living and quality of life. *Neurologia neurochirurgia polska*, *53*(6), 449-457.
- Seim, C. E., Wolf, S. L. & Starner, T. E. (2021). Wearable vibrotactile stimulation for upper extremity rehabilitation in chronic stroke: clinical feasibility trial using the VTS Glove. *Journal of Neuro Engineering and Rehabilitation*, *18*(1), 1-11.
- Semrau, J. A., Herter, T. M., Scott, S. H. & Dukelow, S. P. (2013). Robotic identification of kinesthetic deficits after stroke. *Stroke Journal*, *44*(12), 3414-3421.
- Sheng, B. & Lin, M. (2009). A longitudinal study of functional magnetic resonance imaging in upper-limb hemiplegia after stroke treated with constraint-induced movement therapy. *Brain injury*, *23*(1), 65-70.
- Sinden, J. D., Hicks, C., Stroemer, P., Vishnubhatla, I. & Corteling, R. (2017). Human neural stem cell therapy for chronic ischemic stroke: charting progress from laboratory to patients. *Stem cells and development*, *26*(13), 933-947.

- Smaha, L. A. (2004). The American Heart Association get with the guidelines program. *American heart journal*, *148*(5), S46-S48.
- Stevens, J. A. & Ellen Phillips Stoykov, M. (2004). Simulation of bilateral movement training through mirror reflection: a case report demonstrating an occupational therapy technique for hemiparesis. *Topics in Stroke Rehabilitation*, *11*(1), 59-66.
- Syed, M. J., Khatri, I. A., Alamgir, W. & Wasay, M. (2022). Stroke at moderate and high altitude. *High Altitude Medicine & Biology*, *23*(1), 1-7.
- Thrasher, T. A., Zivanovic, V., McIlroy, W. & Popovic, M. R. (2008). Rehabilitation of reaching and grasping function in severe hemiplegic patients using functional electrical stimulation therapy. *Neurorehabilitation and neural repair*, *22*(6), 706-714.
- Van Criekinge, T., Saeys, W., Hallemans, A., Velghe, S., Viskens, P. J., Vereeck, L. & Truijen, S. (2017). Trunk biomechanics during hemiplegic gait after stroke: a systematic review. *Gait & posture*, *54*, 133-143.
- Van-Ommeren, A. L., Smulders, L. C., Prange-Lasonder, G. B., Buurke, J. H., Veltink, P. H. & Rietman, J. S. (2018). Assistive technology for the upper extremities after stroke: systematic review of users' needs. *JMIR rehabilitation and assistive technologies*, *5*(2), e10510.
- Verheyden, G., Vereeck, L., Truijen, S., Troch, M., Herregodts, I., Lafosse, C. & De Weerdt, W. (2006). Trunk performance after stroke and the relationship with balance, gait and functional ability. *Clinical rehabilitation*, *20*(5), 451-458.
- Waller, S. M. & Whitall, J. (2008). Bilateral arm training: why and who benefits? *Neuro Rehabilitation*, *23*(1), 29-41.
- Ward, N. S., Brander, F. & Kelly, K. (2019). Intensive upper limb neurorehabilitation in chronic stroke: outcomes from the Queen Square programme. *Journal of Neurology, Neurosurgery & Psychiatry*, *90*(5), 498-506.
- Winstein, C., Lewthwaite, R., Blanton, S. R., Wolf, L. B. & Wishart, L. (2014). Infusing motor learning research into neurorehabilitation practice: a historical perspective with case exemplar from the accelerated skill acquisition program. *Journal of neurologic physical therapy: JNPT*, *38*(3), 190.

- Wist, S., Clivaz, J. & Sattelmayer, M. (2016). Muscle strengthening for hemiparesis after stroke: A meta-analysis. *Annals of physical and rehabilitation medicine*, *59*(2), 114-124.
- Wolf, T. J., Polatajko, H., Baum, C., Rios, J., Cirone, D., Doherty, M. & McEwen, S. (2016). Combined cognitive-strategy and task-specific training affects cognition and upper-extremity function in subacute stroke: an exploratory randomized controlled trial. *The American Journal of Occupational Therapy*, *70*(2), 70022900101-700229001010.
- Wu, C. Y., Yang, C. L., Chen, M. D., Lin, K. C. & Wu, L. L. (2013). Unilateral versus bilateral robot-assisted rehabilitation on arm-trunk control and functions post stroke: a randomized controlled trial. *Journal of Neuro Engineering and Rehabilitation*, *10*(1), 1-10.
- Zaheer, S., Beg, M., Rizvi, I., Islam, N., Ullah, E. & Akhtar, N. (2013). Correlation between serum neuron specific enolase and functional neurological outcome in patients of acute ischemic stroke. *Annals of Indian Academy of Neurology*, *16*(4), 504.

CHAPTER-VII **ANNEXURE**

Annexure-1

PEDro Search Strategy

The Physiotherapy Evidence Database (PEDro) search strategy

Search number	Therapy	Problem	Body part	Sub-category	Type
	Stretching/Mobilization /Massage	pain/spasticity	Arm/shoulder /wrist/hand	Neuro	RCT
	Strength training /neurofacilitation /skill training /electromodalities	/Muscle weakness /motor incoordination /hand diability	Arm/shoulder /wrist/hand	Neuro	RCT
	AROM/ Functional training	ROM/ disability	Arm/shoulder /wrist/hand	Neuro	RCT
	Stretching/Mobilization /Massage	pain/spasticity	fore-arm/elbow	Neuro	RCT

PubMed (MEDLNE) Search Strategy

Query (Sort By)
(((((((((Stroke) OR (Hemorrhagic stroke)) OR (Ischemic stroke)) OR (Cerebrovascular accident)) OR (Cerebral infarct))) AND ((((((((((Physiotherapy) OR (Physical Therapy)) OR (Upper limb physiotherapy)) OR (Upper limb rehabilitation)) OR (Upper limb rehabilitation exercise)) OR (Upper limb motor training)) OR (Upper limb task-oriented activity training)) OR (Upper limb virtual rehabilitation)) OR (Upper limb robotic therapy)))) AND (((((((pain) OR (spasticity)) OR (function)) OR (balance)) OR (range of motion)) OR (disability)))) NOT (((((((Only medication) OR (Post operative)) OR (Only surgery)) OR (Occupational therapy)) OR (Speech language therapy)) OR (orthosis prosthesis)))) AND ((("2012/01/01"[Date - Publication] : "2022/12/30"[Date - Publication])))
(((((((((Stroke) OR (Hemorrhagic stroke)) OR (Ischemic stroke)) OR (Cerebrovascular accident)) OR (Cerebral infarct))) AND ((((((((((Physiotherapy) OR (Physical Therapy)) OR (Upper limb physiotherapy)) OR (Upper limb rehabilitation)) OR (Upper limb rehabilitation exercise)) OR (Upper limb motor training)) OR (Upper limb task-oriented activity training)) OR (Upper limb virtual rehabilitation)) OR (Upper limb robotic therapy)))) AND (((((((pain) OR (spasticity)) OR (function)) OR (balance)) OR (range of motion)) OR (disability)))) NOT (((((((Only medication) OR (Post operative)) OR (Only surgery)) OR (Occupational therapy)) OR (Speech language therapy)) OR (orthosis prosthesis)))) AND ((("2012/01/01"[Date - Publication] : "2022/12/30"[Date - Publication])))
(((((((((Stroke) OR (Hemorrhagic stroke)) OR (Ischemic stroke)) OR (Cerebrovascular accident)) OR (Cerebral infarct))) AND ((((((((((Physiotherapy) OR (Physical Therapy)) OR (Upper limb physiotherapy)) OR (Upper limb rehabilitation)) OR (Upper limb rehabilitation exercise)) OR (Upper limb motor training)) OR (Upper limb task-oriented activity training)) OR (Upper limb virtual rehabilitation)) OR (Upper limb robotic therapy)))) AND (((((((pain) OR (spasticity)) OR (function)) OR (balance)) OR (range of motion)) OR (disability)))) NOT (((((((Only medication) OR (Post operative)) OR (Only surgery)) OR (Occupational therapy)) OR (Speech language therapy)) OR (orthosis prosthesis)))) AND ((("2012/01/01"[Date - Publication] : "2022/12/30"[Date - Publication])))
(((((((((Stroke) OR (Hemorrhagic stroke)) OR (Ischemic stroke)) OR (Cerebrovascular accident)) OR (Cerebral infarct))) AND ((((((((((Physiotherapy) OR (Physical Therapy)) OR (Upper limb physiotherapy)) OR (Upper limb rehabilitation)) OR (Upper limb rehabilitation exercise)) OR (Upper limb motor training)) OR (Upper limb task-oriented activity training)) OR (Upper limb virtual rehabilitation)) OR (Upper limb robotic therapy)))) AND (((((((pain) OR (spasticity)) OR (function)) OR (balance)) OR (range of motion)) OR (disability)))) NOT (((((((Only medication) OR (Post operative)) OR (Only surgery)) OR (Occupational therapy)) OR (Speech language therapy)) OR (orthosis prosthesis)))) AND ((("2012/01/01"[Date - Publication] : "2022/12/30"[Date - Publication])))
(("2012/01/01"[Date - Publication] : "2022/12/30"[Date - Publication]))

((((((Only medication) OR (Post operative)) OR (Only surgery)) OR (Occupational therapy)) OR (Speech language therapy)) OR (orthosis prosthesis))
((((((pain) OR (spasticity)) OR (function)) OR (balance)) OR (range of motion)) OR (disability))
((((((((Physiotherapy) OR (Physical Therapy)) OR (Upper limb physiotherapy)) OR (Upper limb rehabilitation)) OR (Upper limb rehabilitation exercise)) OR (Upper limb motor training)) OR (Upper limb task-oriented activity training)) OR (Upper limb virtual rehabilitation)) OR (Upper limb robotic therapy))
(((((Stroke) OR (Hemorrhagic stroke)) OR (Ischemic stroke)) OR (Cerebrovascular accident)) OR (Cerebral infarct))

Cochrane library Search Strategy
Search Name: Stroke_Ershad
Date Run: 25/10/2022 01:18:14
Comment: **1956**

ID Search Hits
#1 MeSH descriptor: [Stroke] explode all trees 11756
#2 MeSH descriptor: [Hemorrhagic Stroke] explode all trees 19
#3 MeSH descriptor: [Ischemic Stroke] explode all trees 412
#4 MeSH descriptor: [Stroke] explode all trees 11756
#5 MeSH descriptor: [Cerebral Infarction] explode all trees 1290
#6 #1 or #2 or #3 or #4 or #5 with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 7800
#7 Physiotherapy with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 13417
#8 Physical Therapy with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 46847
#9 rehabilitation with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 47087
#10 "motor training" with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 579
#11 "task-oriented activity training" with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 3
#12 "virtual rehabilitation" with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 63
#13 "upper limb robotic therapy" with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 11
#14 #7 or #8 or #9 or #10 or #11 or #12 or #13 85284
#15 pain with Publication Year from 2012 to 2022, in Trials (Word variations have been searched)141369
#16 spasticity with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 3327
#17 function with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 198470
#18 balance with Publication Year from 2012 to 2022, in Trials (Word variations have been searched)31909
#19 "range of motion" with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 11363
#20 disability with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 35027
#21 #15 or #16 or #17 or #18 or #19 or #20 280395
#22 medication with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 238670
#23 "Post operative" with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 19106
#24 surgery with Publication Year from 2012 to 2022, in Trials (Word variations have

been searched) 161899
#25 Occupational therapy with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 5754
#26 Speech language therapy with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 2843
#27 MeSH descriptor: [Orthotic Devices] explode all trees 1871
#28 #22 or #23 or #24 or #25 or #26 or #27 217871
#29 MeSH descriptor: [Physical Therapy Modalities] explode all trees 29938
#30 MeSH descriptor: [Exercise Therapy] explode all trees 16435
#31 MeSH descriptor: [Motor Activity] explode all trees 31922
#32 MeSH descriptor: [Exercise] explode all trees 28782
#33 #29 or #30 or #31 or #32 52365
#34 #14 or #33 123754
#35 #6 and #34 and #21 2344
#36 #35 not #28 with Publication Year from 2012 to 2022, in Trials (Word variations have been searched) 1956

Scopus Search Strategy

(TITLE-ABS-KEY (stroke) OR TITLE-ABS-KEY (cerebrovascular))
AND
(TITLE-ABS-KEY (physiotherapy) OR TITLE-ABS-KEY ("Physical Therapy") OR TITLE-ABS-KEY ("upper limb physiotherapy") OR TITLE-ABS-KEY ("upper limb motor training") OR TITLE-ABS-KEY ("upper limb rehabilitation") OR TITLE-ABS-KEY ("upper limb therapy"))
AND
(TITLE-ABS-KEY (pain) OR TITLE-ABS-KEY (spasticity) OR TITLE-ABS-KEY ("physical function*") OR TITLE-ABS-KEY (disability))
AND
(LIMIT-TO (SRCTYPE , "j"))
AND
(LIMIT-TO (DOCTYPE , "ar"))
AND
(LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012))
AND
(LIMIT-TO (LANGUAGE , "English"))

Result: **1,117**

Web of Science Search Strategy

1: ((((((TS=(stroke)) OR TS=(Hemorrhagic stroke)) OR TS=(Ischemic stroke)) OR TS=(Cerebrovascular accident)) OR TS=(Cerebral infarct*)) OR TS=(Cerebro vascular accident)) OR TS=(Cerebro-vascular accident) Date run: Tue Oct 04 2022 17:44:23 GMT+0600 (East Kazakhstan Time) Results: 565650

2: (((((((((TS=(Physiotherapy)) OR TS=(Physio*)) OR TS=(Physical Therap*)) OR TS=(Upper limb physiotherap*)) OR TS=(Upper limb rehabilitation)) OR TS=(Upper limb rehabilitation exercise*)) OR TS=(Upper limb motor training)) OR TS=(Upper limb task-oriented activity training)) OR TS=(Upper limb virtual rehabilitation)) OR TS=(Upper limb robotic therapy) Date run: Tue Oct 04 2022 17:49:00 GMT+0600 (East Kazakhstan Time) Results: 14108416

3: ((((((TS=(pain)) OR TS=(spasticity)) OR TS=(physical function)) OR TS=(Improved function)) OR TS=(balance)) OR TS=(motion)) OR TS=(disability)

Date run: Tue Oct 04 2022 17:51:15 GMT+0600 (East Kazakhstan Time)

Results: 4472701

4: PY=(2012-2022) Date run: Tue Oct 04 2022 17:56:55 GMT+0600 (East Kazakhstan Time) Results: 33439927

5: #1 AND #2 AND #3 AND #4 Date run: Tue Oct 04 2022 17:57:20 GMT+0600 (East Kazakhstan Time) Results: 28423

6: #1 AND #2 AND #3 AND #4 and Clinical Trial (Document Types)

Date run: Tue Oct 04 2022 17:57:34 GMT+0600 (East Kazakhstan Time)

Results: 3219

7: #1 AND #2 AND #3 AND #4 and Clinical Trial (Document Types) and English (Languages) Date run: Tue Oct 04 2022 17:58:08 GMT+0600 (East Kazakhstan Time) Results: 3204

Total from Web of Science: **3204**

Annexure -2

Data extraction form

JBI Data Extraction Form for Review

1. Study numbering
2. Author
3. Year of publication
4. Title of study
5. Setting/context
6. Description of Interventions
7. Comments

Annexure-03

RoB2 for Systematic Reviews and Research Syntheses

1. Identification Number

2. Characteristics of the study

a. Study Details Author
b. Journal
c. Year
d. Country
e. Number of participants
f. Randomization
g. Dropout rate

3. Participants characteristics

a. Age
b. Gender (M)
c. Gender (F)

4. Pattern of stroke

a. Ischemic
b. Hemorrhagic
c. Both

5. Intervention (EG)

Experimental group

a. Type
b. Name
c. Dose

Control group

a. Type
b. Name
c. Dose

6. Outcome

7. Tools for outcome

8. Remarks

বাংলাদেশ হেল্থ প্রফেশন্স ইনস্টিটিউট (বিএইচপিআই)
Bangladesh Health Professions Institute (BHPI)
(The Academic Institute of CRP)

BANGLADESH HEALTH PROFESSIONS INSTITUTE

Ref: CRP-BHPI/IRB/10/2022/662

Date: 25/10/2022

To
Md. Ershad Ali
M.Sc. in Physiotherapy (Part-II)
Session: 2020-2021 Du Reg No.5247
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Subject: Approval of the thesis proposal **"Evidence Based Physiotherapy Treatment for Improving Motor of Function of Upper Limb for Stroke Survivors-A Systematic Review"** by ethics committee.

Dear
Md. Ershad Ali
Congratulations.
The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the above-mentioned dissertation, with yourself, as the principal investigator. The Following documents have been reviewed and approved:

Sr. No.	Name of the Documents
1	Dissertation Proposal Physiotherapy Evidence Database

The purpose of the study is to form a series of recommended physiotherapy interventions by ensuring the current and available evidence for the upper limb Motor rehabilitation of stroke survivors. The study involves structured search strategies to review literatures related to physiotherapy interventions at different stages of stroke & identify the evidence-based physiotherapy treatment with a comprehensive physiotherapy guideline for upper limb stroke rehabilitation. The members of the Ethics committee have approved the study to be conducted in the presented form at the 33rd IRB meeting held at 09.00 AM on 24th September 2022 at BHPI.

The institutional Ethics committee expects to be informed about the progress of the study, any changes occurring during the study, any revision in the protocol and ask to be provided a copy of the final report. This Ethics committee is working accordance to Nuremberg Code 1947, World Medical Association Declaration of Helsinki, 1964 - 2013 and other applicable regulation.

Best regards,

Muhammad Millat Hossain
Associate Professor, Dept. of Rehabilitation Science
Member Secretary, Institutional Review Board (IRB)
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

সিআরপি-চাপাইন, সাভার, ঢাকা-১৩৪৩, বাংলাদেশ। ফোন: +৮৮ ০২ ২২৪৪৪৫৪৬৪-৫, +৮৮ ০২ ২২৪৪৪১৪০৪, মোবাইল: +৮৮ ০১৭৩০ ০৫৯৬৪৭
CRP-Chapain, Savar, Dhaka-1343, Bangladesh. Tel: +88 02 224445464-5, +88 02 224441404, Mobile: +88 01730059647
E-mail : principal-bhpi@crp-bangladesh.org, Web: bhpi.edu.bd