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Therapeutic efficacy of modified Constraint Induced Movement Therapy on patients with gait dysfunction in the stroke population: A randomized clinical trial

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We the undersigned, certify that we have carefully read and recommend to the Faculty of Medicine, University of Dhaka, for the acceptance of this dissertation entitled, **"Therapeutic efficacy of modified Constraint Induced Movement Therapy on patients with gait dysfunction in the stroke population: A randomized clinical trial"** Submitted by **Rubyat Sharmin Ruma**, for the partial fulfillment of the requirement for the degree of Bachelor of Science in Physiotherapy (B.Sc. in PT).

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Declaration

I declare that the work presented here is my own. All sources used have been cited appropriately. Any mistakes or inaccuracies are my own. I also declare that for any publication, presentation or dissemination of information of the study, I would be bound to take written consent from the Supervisor & Department of Physiotherapy of Bangladesh Health Professions Institute (BHPI).

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Contents

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Acronyms

10MWT	10-meter walk test
3DGA	3-D gait analysis
6minWT	6-min walk test
AFO	Ankle-Foot Orthoses
BBS	Berg Balance Scale
BHPI	Bangladesh Health Professions Institute
BMRC	Bangladesh Medical Research Council
CIMT	Constraint-Induced Movement Therapy
CRP	Centre for the Rehabilitation of the Paralysed
DALYs	Disability-Adjusted Life-Years
FAC	Functional Ambulation Categories
FMA	Fugl-Meyer Assessment
IRB	Institutional Review Board
LE-CIMT	Lower Extremity Constraint-Induced Movement Therapy
MAS	Modified Ashworth Scale
MBI	Modified Barthel Index
mCIMT	Modified constraint-induced movement therapy
MI	Motricity Index
NDT	Neurodevelopmental Therapy
RCT	Randomized Clinical Trials
SIS	Stroke Impact Scale
SLS	Single-Leg stance
SPSS	Statistical Package for Social Science
SS-QoL	Stroke Specific Quality of Life
TUG	Timed Up and Go test
WHO	World Health Organization

List of tables

List of figures

Abstract

Background: Post-stroke complications often include gait dysfunction due to impaired motor control, balance, and mobility, significantly affecting patients' independence and quality of life. Constraint-induced movement therapy (CIMT), a motor rehabilitation technique, is often used to restore impaired limb motor function after and reduce learned nonuse. Building upon the success of CIMT in upper extremity rehabilitation for stroke patients, modified CIMT (mCIMT) has been introduced for lower extremity training in stroke patients. However, there is still not enough strong evidence to prove how effective mCIMT is for lower extremity rehabilitation, and more research is needed. **Objectives:** To evaluate the therapeutic efficacy of modified Constraint Induced Movement Therapy (mCIMT) for the lower extremity in patients with gait dysfunction in the stroke population. **Methodology:** A single-blind randomized clinical trial was conducted at CRP, Savar, Bangladesh, involving 42 stroke patients (22 in the experimental group and 20 in the control group). The experimental group received mCIMT with conventional physiotherapy, while the control group received only conventional therapy. The outcome measures were evaluated by the ten-meter walk test, timed up and go test, single limb stance test and functional ambulation category. **Results:** After the 16 sessions of intervention, significant improvements were observed in the experimental group. Between-group analysis: the Timed Up and Go test and the 10-meter walk test showed statistically significant improvements in the experimental group ($p = 0.038$ and $p = 0.029$). On the other hand, the between-group analysis, the single limb stance test for the affected limb and unaffected limb, the p-value was 0.124 and 0.001. Lastly, between-group analysis: the functional ambulation category showed statistically not significant improvements in the experimental group ($p = 0.172$). **Discussion:** The findings suggest that modified Constraint-Induced Movement Therapy (mCIMT) helps stroke patients improve their walking ability more than conventional physiotherapy alone. Patients who received mCIMT showed better balance, faster walking, and to encouraged to use their weaker leg, helping to reduce the habit of avoiding it (known as "learned non-use"). Because mCIMT uses simple exercises and doesn't require expensive equipment, it can be a useful and practical treatment method, especially in resource-limited settings like Bangladesh.

Keywords: *stroke, gait dysfunction, modified constraint-induced movement therapy.*

Chapter-i Introduction

1.1 Background:

The World Health Organization (WHO) regards stroke as the "clinical evidence of a permanent (or global) impairment of brain function that is rapidly increasing, with signs and symptoms lasting more than 24 hours or leading to death with no apparent reason other than vascular origin" (Chavan and Raghuveer, 2024). Stroke is the second biggest cause of global mortality, affecting 15 million people annually. Over the last two decades, stroke cases in Asian countries have increased by twofold. In South Asia, 13.4% of stroke patients had concomitant illnesses, including dyslipidemia, diabetes, and hypertension, which are often uncontrolled. Stroke patients usually experience loss of skeletal muscle mass and function. It may impede patient mobility, hence adversely impacting activities of daily living (ADLs) and resulting in decreased participation in everyday activities (Afridi et al., 2023).

Stroke is one of the leading causes of death and disability worldwide (Zhang et al., 2023). And it also brings about great physical and psychological stress on caregivers (Liping et al., 2024). Nonetheless, long-term disability, poor participation, and activity restrictions are common in stroke survivors (Zhang et al., 2023). Patients may need long-term care, imposing a burden on families and society (Zhou et al., 2022). The prevalence of stroke remains a significant public health issue. In 2019, stroke ranked as the second leading cause of mortality and disability globally. The incidence, prevalence, mortality, and disability-adjusted life years (DALY) associated with stroke have been increasing at a much higher rate in low- and middle-income countries (LMICs) compared to high-income countries over the past five decades (1970-2019) (Owolabi et al., 2021).

Common post-stroke complications include stiffness, fatigue, and loss of balance on the affected side, as well as gait impairment that makes it challenging to maintain postural alignment. When a stroke occurs, paralysis typically occurs on the side of the body opposite the damaged brain. A single leg, the face, an upper or lower limb, or the entire side of the body may all be impacted. A designed program can significantly

increase documented patient activity levels during inpatient stroke therapy without requiring more resources (Chavan and Raghuveer, 2024).

Gait dysfunction has a relatively high prevalence among stroke survivors. Initially, gait pathology is linked to a significant clinical presentation of gait asymmetry compared to healthy individuals (Li, Francisco, & Zhou, 2018). Roughly 70-80% stroke victims are discharged with residual gait speed and walking distance not reaching the parameters for community ambulation, resulting in a high rate of falls (Yang et al., 2024). Gait abnormalities, including reduced speed, limited distance, and impaired independence, are frequently observed in patients with stroke (Hosoi et al., 2016). Stroke patients typically have a reduced stance duration, an unbalanced stance, and an extended swing phase on the affected extremity. Furthermore, both walking speed and stride length are reduced (Li, Francisco and Zhou, 2018; Umar and Abdullahi, 2020). These walking limitations impair the patients' mobility, increase the burden on caregivers, and have a deleterious effect on the patients' psychological well-being (Yu et al., 2021).

No more than one-third of patients are working within a year after rehabilitation. It is important to help stroke survivors recover lower limb motor function for independence and community reintegration (Zhou et al., 2022). Rehabilitation for patients with stroke is mainly targeted at securing functional walking. By walking, patients gain independence and feel capable. Enhancing self-efficacy is associated with better total results (Liping et al., 2024). The CIMT is based on the principle of "learned non-use". Stroke survivors may develop non-use, a condition wherein they utilize unaffected limbs to compensate for the impaired ones, thereby enhancing their residual mobility. CIMT improves gait attributes, including ambulation, velocity, momentum, quality, and cerebral function (Afridi et al., 2023). CIMT, as a movement therapy, is often applied to regain the decreased limb movement ability following stroke for the purpose of activities of daily living and not learned nonuse (Zhou et al., 2022).

Morris, Morris and Iansek (2001) and Shi et al. (2011) argued that longer periods of restraint and more practice trials may place patients at risk during treatment. Likewise, patients may have difficulty performing a full practice session of this duration, and results have been called into question regarding the therapeutic benefits of CIMT. The CIMT restriction regime is adhered to by only 32% of patients (Page et al., 2002; Sunderland and Tuke, 2005; Shi et al., 2011). Page and co-workers developed modified

CIMT in accordance with the principles stated above, reducing the length of time the unaffected upper extremity is restrained (60% of waking hours, ~6h/d), and of the intensive training for the affected upper extremity (30min/d - 2h/d) (Shi et al., 2011).

Modified constraint-induced movement therapy (mCIMT) is a therapeutic intervention for individuals with motor impairments. The conventional approach to treating the affected upper limb increases use and prevents "learned disuse" after a stroke. Modified-CIMT is a repetitive, structured treatment of the affected limb, constraint of the affected limb, and behavioral shaping strategies to generalize functional gains to everyday life (Chavan and Raghuveer, 2024).

Constraint-Induced Movement Therapy (CIMT) combines behavioral and neurological mechanisms to improve neuroplasticity and cortical reconfiguration. It addresses learned nonuse by constraining the unaffected extremities and repeatedly utilizing the affected extremities (Liping et al., 2024). Constraint-induced movement therapy (CIMT) involves restricting the unaffected limb, performing mass tasks with the affected limb, and employing a transfer package to enhance upper limb function (Zhang et al., 2023). However, modified CIMT (mCIMT) can improve the use of paralyzed lower extremities (LE) and rehabilitation. mCIMT offers a more flexible protocol, incorporating partial constraint, intense exercise, shape training, and a transfer package. The goal of applying mCIMT is to enhance LE movement disorders. (Liping et al., 2024).

Thus, the aim of this study is to evaluate the effectiveness of modified Constraint-Induced Movement Therapy (mCIMT) on patients with gait dysfunction in the stroke population. The intervention targets the overall activity of walking, necessitating the use of both lower extremities. Consequently, it is anticipated that these modifications will enhance activity in both the paretic (more affected) and non-paretic (less affected) lower extremities after the completion of modified CIMT training and following 16 sessions of the intervention.

1.2 Rationale:

The primary aim of this study is to evaluate the effectiveness of modified Constraint-Induced Movement Therapy (mCIMT) in conjunction with traditional physiotherapy for patients with post-stroke gait dysfunction. Stroke is a devastating condition affecting both cognitive and physical functions. During the stroke, lower limb movement can be dramatically altered, leading to abnormal movement patterns. In our country, treatment is given with certain limitations. There are several kinds of rehabilitation methods that enhance the function of the lower limbs. To address the issue of learned nonuse of the affected lower extremity during movement in post-stroke, it's important to break the "learned non-use" phenomenon. To treat nonuse of the paretic lower limb during ambulation post-stroke, the phenomena of "learned non-use" must be surmounted. Constraint-Induced Movement Therapy (CIMT) is a neuro-rehabilitative strategy employed to recover motor function in the affected limb post-stroke, facilitating the resumption of everyday activities and reducing learned nonuse. Traditional CIMT requires prolonged limb restriction and extensive training, which can be excessively difficult for patients both physically and psychologically. In contrast to traditional CIMT, the modified Constraint-Induced Movement Therapy (mCIMT) effectively decreases the training intensity for the affected limb and the duration of restriction on the unaffected limb; hence, the mCIMT protocol is more suitable, particularly for elderly patients.

There is no established research in Bangladesh in this area yet. This type of research has not been done in our country to the best of our knowledge. Thus, the existing gap in knowledge should be filled for the ultimate benefit of patient care, and thereby, research should. It also helps define the appropriate criteria, concepts, and instructions of specific protocols of a stroke rehabilitation treatment regimen aimed at enhancing gait, balance, and minimizing impairments in stroke patients. The objective of this study was to examine the effects of modified Constraint-Induced Movement Therapy (mCIMT) in patients with post-stroke gait dysfunction.

1.3 Aim: To evaluate the therapeutic efficacy of modified Constraint Induced Movement Therapy (mCIMT) for the lower limb in patients with gait dysfunction in the stroke population.

1.4 Objectives of the study:

General objectives:

To evaluate the effectiveness of modified Constraint Induced Movement Therapy (mCIMT) along with conventional physiotherapy for the lower limb in patients with gait dysfunction in the stroke population.

Specific objectives:

1. To find out the effectiveness of conventional therapy and modified constraint-induced movement therapy for the lower extremities to improve gait as assessed by the single limb stance test, Functional Ambulation Category, 10-meter walk test, and timed up and go test.
2. To compare the effectiveness of conventional therapy and modified constraint-induced movement therapy for the lower extremities to improve gait (using single limb stance test, Functional ambulation category, 10-meter walk test, timed up and go test).
3. To explore the sociodemographic features of the participants.

1.5 Hypothesis:

Null hypothesis (H_O)

Modified constraint-induced movement therapy, when paired with traditional physiotherapy, does not demonstrate greater efficacy than conventional physiotherapy alone in patients with gait dysfunction in the stroke population.

Ho: $\mu 1 - \mu 2 = 0$ or $\mu 1 = \mu 2$, indicating that the mean difference between the experimental group and the control group is equivalent. ($\mu 1$ = mean initial change, $\mu 2$ = mean final change)

Alternative hypothesis (H_A)

Modified constraint-induced movement therapy is more effective than conventional physiotherapy alone for patients with gait dysfunction in the stroke population.

H_A: $\mu 1 - \mu 2 \neq 0$ or $\mu 1 \neq \mu 2$, indicating that the difference between the initial and final means of the experimental and control groups are not equivalent. ($\mu 1$ = mean initial change, $\mu 2$ = mean final change)

1.6 Operational definition:

Stroke: Stroke is characterized as a rapidly evolving clinical manifestation of a localized disruption in brain function, persisting for more than 24 hours, with no identifiable cause other than a vascular origin or mortality. This condition is classified as a clinical syndrome.

Gait dysfunction: Gait dysfunction refers to the alteration in the way of walking, such as gait asymmetry, deficit in gait speed and walking distance, shorter stance phase, longer swing phase, shorter stride length, and asymmetry stance.

Constraint Induced Movement Therapy: Constraint Induced Movement Therapy (CIMT) is a therapeutic approach that entails the restriction of the unaffected limb to promote the utilization of the affected limb following a stroke.

Modified Constraint Induced Movement Therapy: Modified Constraint Induced Movement Therapy (mCIMT) is a therapeutic approach designed to enhance function and independence in the affected limb following a stroke, which requires less constraint time rather than a longer period.

Chapter-ii Literature review

Stroke

Among various nations, stroke is one of the major causes of death and disability (Venketasubramanian et al., 2017). An estimated 25.7 million stroke survivors worldwide, 6.5 million stroke deaths, 113 million stroke disability-adjusted life-years (DALYs) and 10.3 million new stroke cases (Feigin et al., 2015; Venketasubramanian et al., 2017). Strokes were responsible for 81.0% of D ALYs lost and 75.2% of all stroke deaths and were most severe in developing countries (Venketasubramanian et al., 2017).

Three of the top ten most populous countries in the world, namely, India, Pakistan, and Bangladesh, are located in South Asia, which represents over 40% of the population of the developing world and 22% of the entire 1.560 billion world population (Wasay et al., 2014). Based on WHO data collected in 2001, nearly 86% of stroke-related deaths worldwide occurred in low-resource countries (Wasay et al., 2014; Feigin et al., 2017). While Asian countries have a high number of stroke victims, they also have limited financial and personnel resources, including neurologists and stroke specialists. Understanding the unique characteristics of stroke in South Asia is essential to lowering the incidence and enhancing outcomes in this area (Wasay et al., 2014).

Gait dysfunction

One of the most frequent and devastating physiological effects of stroke is gait dysfunction or impairment. For stroke sufferers with gait handicaps and their clinical teams, maintaining optimal gait is a crucial objective. Sensorimotor dysfunction, which includes muscle weakness, perceptual and proprioceptive impairments, spasticity, or hypotonia, is the primary cause of gait problems in stroke patients. Post-stroke disability has been linked to reduced walking pace, shorter and narrower steps, difficulties climbing stairs, and the inability to walk a mile (1,609 m). Even though 52–85% of people who have had hemiplegic strokes can walk again, their gait patterns usually remain different from those of healthy people, which hurts their quality of life, biomechanics, and general bodily function (Mohan et al., 2021).

25% of survivors require complete physical assistance walking before hospital discharge, and approximately one-third of survivors who present with initial lower extremity paralysis do not regain functional walking despite structured rehabilitation. Post-stroke gait disorder is one of the neurological gait abnormalities most investigated. The condition generally presents as an obvious asymmetrical loss. The restoration of gait is a primary objective of post-stroke therapy. Many techniques have been explored in the past to recover walking capacity. This involves compensatory techniques, including walking or cane use and ankle-foot orthoses (AFO). These techniques are predicated on supporting certain body parts while they engage in an activity. Over the past ten years, research has been conducted on rehabilitation techniques that target the brain and related regions to enhance gait in stroke survivors (Verma et al., 2012).

Constraint-Induced Movement Therapy (CIMT)

Dr. Taub's original research in the late 1970's and early 1980's laid the groundwork for CIMT. First, he did a dorsal rhizotomy for the limbs to cut off somatic sensation in the arms. CIMT is based on the theory of "learned non-use". Early post-stroke learned non-use is due to compensating behavior of progressively utilizing the unaffected limb, since movement with the affected arm is more painful. This compensation has been shown to inhibit functional recovery of the injured limb (Grotta et al., 2004).

The objective of CIMT is to facilitate function of the paretic limb post-stroke by restraining the nonparetic limb while the paretic limb is engaged. The basic concept of CIMT employs movement techniques, behavioral strategies, and restriction technologies to increase the utilization of the affected limb in stroke patients, enhance the quality of limb movement during daily activities, prevent or reverse learned non-use of the affected limb, and promote the recovery of motor function in the affected limb. This treatment encourages the utilization of the damaged arm, rectifies or mitigates the disuse or neglect of the impaired limb, and provides structural and functional training along with opportunities for repetitive practice. Numerous studies have substantiated the efficacy of CIMT, a rehabilitation technique that entails repetitive rigorous unilateral limb training, in improving motor function of the afflicted limb. (Hu and Bai, 2020; Wang et al., 2022).

García-Salazar et al. (2022) performed an experiment using 12 individuals with chronic hemiparesis due to stroke (36–78 years). After the clinical assessment, subjects received the LE-CIMT training. The intervention lasted for 10 days. Each session included 2.5 hours of task practice and 30 minutes of transfer package use. In this study, vector coding was implemented to analyze the joint angles (swing and stance) during walking as well as synchronization of hip-knee joints. This study detected differences in joint angle kinematics among involved limbs. Based on their theoretical framework, they found that LE-CIMT improved intra-limb coordination early on by increasing stability and variability in the initial pattern, and later by reducing variability after 30 days. These results suggest that the LE-CIMT intervention has potential, with substantial changes even in a small period of intervention in this group.

The study was carried out by Aloraini (2022) as a randomized, controlled, single-blinded clinical trial on 38 subjects (19 subjects in each group). The outcome measures included Berg Balance Scale, Fugl-Meyer Assessment of the Lower Extremity, 10-Meter Walk Test, and Six-Minute Walk Distance. Outcome measurements were collected at baseline, 3 months later, and after completion of the therapy programs. At posttreatment assessments, participants in both groups showed statistically significant improvement from baseline. Nevertheless, the changes in the LE-CIMT were also clinically significant. Moreover, 3 months after the training had finished, participants maintained the gains that had been recorded. A psychometric report on the family-CIMT-home program ADL outcomes. When compared with an intensity-matched traditional regimen, a home-based LE-CIMT program had substantial clinical gains in stroke survivors. Motor recovery of the lower extremity, postural stability, and gait velocity showed considerable enhancement. Furthermore, these advantages were sustained three months after the conclusion of the therapy session.

e Silva et al. (2017) documented a study comprising 38 subacute stroke survivors. The participants were randomly allocated to either treadmill training with weights restricting the movement of the non-paretic ankle (experimental group) or treadmill training without additional load (control group). Both groups engaged in daily training throughout a two-week period, comprising nine sessions, and additionally completed home workouts during this timeframe. Static balance (BBS) and functional mobility (TUG test and turning kinematic features using the Qualisys System for movement

analysis) were assessed at pre-training, mid-training, post-training, and follow-up intervals. The findings from the repeated-measures ANOVA indicated substantial enhancements in postural balance (BBS) and functional mobility, as assessed by TUG and kinematic turning parameters, following the training session. All increases were observed in both groups and persisted during the follow-up. The findings indicate that two weeks of treadmill gait training combined with home exercise programs are adequate to significantly enhance postural control and gait performance in subacute stroke survivors.

Menezes-Oliveira et al. (2021) conducted a single-blind, randomized, controlled trial with 42 patients with chronic stroke, characterized by decreased gait capacity, who could walk a minimum of 10 meters with or without assistance. Two treatment groups were established: LE-CIT (Lower Extremity Constraint-Induced Therapy) and a control group receiving rigorous conventional therapy. The Mini-BESTest, Timed Up and Go Test (TUG), 3DGA, 6-Minute Walk Test (6minWT), 10-Meter Walk Test (10MWT), and Lower Extremity-Motor Activity Log (LE-MAL) were utilized to assess the outcomes in the current study. All groups engaged in daily physical activity for 15 days, with the LE-CIT group receiving 2.5 hours per day of intensive training that encompassed motor act shaping and a transfer package, while the control group had traditional physiotherapy. Comparative analysis of clinically significant differences between groups will be conducted using repeated measures. The LE-CIT protocol is regarded as a promising rehabilitation approach for stroke patients, as it focuses on the intensity and execution of exercises.

Abdullahi et al. (2021) conducted a randomized clinical trial with 58 stroke patients to compare two rehabilitation approaches. Participants were separated into two groups based on random assignment. For four weeks, Group 1 did strenuous workouts five days a week (stair climbing, ball kicking, side stepping, backward and forward stepping), with 600 repetitions per day spread across three sessions. Group 2 received Altered Constraint-Induced Movement Therapy (CIMT) by executing task practice with limitations for three hours daily, five days weekly, over a duration of four weeks. The study assessed several outcomes, including lower limb motor function (Fugl Meyer), walking speed (Ten-Meter Walk Test), functional mobility (Rivermead Mobility Index), knee extensor spasticity (modified Ashworth scale), balance (Berg

balancing scale), and endurance (Six-Minute Walk Test). Both groups significantly improved their outcomes. Group 1, which followed a greater intensity exercise plan, outperformed the other groups in improving stroke recovery outcomes.

Modified Constraint-Induced Movement Therapy (mCIMT)

Umar, Adegoke & Dada (2024) recruited 46 stroke patients who were divided into 3 groups: Combined mCIMT group (CO, n=16), Lower extremity mCIMT group (LE, n=15) and Upper extremity mCIMT group (UE, n=15) in a randomized trial. For each intervention, the researchers delivered two hours of training for four weeks on five days of the week. The Lower Limb Motor Activity Log, the Fugl-Meyer Assessment, and the Stroke Impact Scale were used to evaluate outcomes. All groups showed significant improvements in motor function, lower limb usage, balance, and overall quality of life. Notably, the LL group demonstrated much higher improvements than the CO and UL groups. They achieved the following results: When improving stroke patients' motor function, mobility, and quality of life, modified LL CIMT outperformed combined or UL-specific mCIMT techniques.

Candan and Livanelioglu (2019) performed a randomized trial study including 30 participants, comparing two groups of patients with stroke. A study group received a 4-week baseline neurodevelopmental therapy (NDT) prior to mCIMT, and a control group received 2 weeks of NDT as an experimental treatment. Outcomes were assessed at three time points (pre-baseline, post-baseline, and post-experimental) using the Motricity Index (MI), Stroke Impact Scale (SIS), and Stroke Specific Quality of Life (SS-QoL). Significant improvements in SS-QoL subdomain scores, including mobility, self-care, upper extremity function, thinking, mood, family, and social roles, were observed within the treatment group, especially in the experimental period. The patients in the research group had a good performance in the paretic lower limb strength during the treatment period. Correlations between the strength of the upper limb and assessments of quality of life were provided for the change between the control and experimental-treatment periods. Among patients with stroke, mCIMT is superior compared with NDT for paretic lower extremity strength and health-related quality of life.

Wei-ming et al. (2015) included 60 acute cerebral stroke patients with limb dysfunction who were divided into a control group (n = 30) with normal rehabilitation treatment and mCIMT. The control group underwent conventional rehabilitation training 1 h twice a day, five times per week, whereas the mCIMT group underwent mCIMT treatment at the same frequency. All patients were trained in an outpatient physiotherapy clinic for 2 weeks and afterwards for 4 weeks in an inpatient rehabilitation clinic. The duration of the treatment was six weeks. All patients underwent assessment using the modified Barthel Index (MBI), Fugl-Meyer Assessment (FMA), and Berg Balance Scale prior to and following medication. Scores for MBI, FMA, and BBS at 2, 6, and 12 weeks post-treatment were elevated in both groups. The MBI, FMA, and BBS scores of the mCIMT group were markedly superior to those of the control group at 2, 6, and 12 weeks post-treatment.

Functional Ambulation Categories (FAC)

The walking test used is the Functional Ambulation Category (FAC). This 6-level scale is based on ambulation with human support when walking, irrespective of the use of personal assistive technology (Teasell et al., 2016). Holden et al. (1984) first reported the description of the FAC developed at the Massachusetts General Hospital. An assessor asks the participant several questions and then assigns a score between 0 (indicating no balance) to 5 (independent) after a brief observation of walking ability (Mehrholz et al., 2007; Collen, Wade and Bradshaw, 1990). 0=patient is nonfunctional ambulator (not able to walk), 1, 2, or 3= patient is dependent ambulator (needs the help of another person in the form of continuous manual contact (1), continuous or intermittent manual contact (2), or verbal supervision/guarding (3), 4 or 5=patient is independent ambulator (able to walk alone) on: level surfaces only (4), or any surface (5=maximum score) (Mehrholz et al., 2007).

Mehrholz et al. (2007) investigated the test-retest reliability (one week apart) of the FAC and applied it to 55 patients after stroke (less than 60 d atm). The FAC demonstrates high test-retest reliability, e.g., as indicated by an excellent correlation (k=.950) between the two evaluations. In another study, the inter-rater reliability of the FACs was tested in 25 participants with chronic stroke (two to six years post-stroke with residual reduced mobility) for Collen, Wade and Bradshaw (1990). The examiner's inter-rater reliability using the kappa statistics was poor (k=0.36). In a study, Mehrholz

et al. (2007) investigated the concurrent validity of the FAC with commonly used gait performance measures (the Rivermead Mobility Index (RMI), the 6 Minute Walk Test (6MWT), walking velocity, and stride length) in 55 patients post-stroke.

Timed up and go (TUG) test

The TUG test is a general physical performance test that assesses mobility, balance, and ambulatory function in older adults with balance problems. It is more sensitive for the assessment of serial motor ability such as in walking and turning (Schoppen et al., 1999; Morris, Morris and Iansek, 2001). Healthy adults 60-80 years old complete the TUG test within 10 sec (Steffen, Hacker, & Mollinger, 2002). The average time for all 80-89 year old males is 10 ± 1 s, whereas for all 80-89 year old females the average is just 11 ± 3 s. There are no formal criteria for stroke patients. Sensitivity and specificity of the timed up-and-go test are estimated at 87% (Shumway-Cook, Brauer and Woollacott, 2000).

Flansbjer et al. (2005) assessed the test-retest reliability of the TUG in 50 patients with mild to moderate chronic post-stroke hemiparesis. The TUG was done by the patients themselves in two occasions, separated by 7 days. The TUG was found to have excellent test-retest reliability. Ng and Hui-Chan (2005) had ten healthy elders and ten individuals with chronic stroke perform the TUG twice a week at random times of day. The researchers also reported substantial test-retest reliability among healthy old adults and after stroke. As a consequence, the results of the present study compare to the study of Flansbjer et al. (2005) TUG is a reliable instrument for stroke patients.

A component of community reintegration that improves quality of life is thought to be community mobility. A suitable gait speed is necessary for good community mobility and independent outdoor ambulation (Grau-Pellicer et al., 2019). The ten-meter walk test estimates a validity of 76% (Tyson and Connell, 2009) and reliability of 94% (Flansbjer et al., 2005). Half of stroke victims are unable to walk even with physical help within a month after their stroke, and two-thirds have limited walking abilities (Cheng et al., 2020). An international post-stroke physical therapy guideline recommends measuring gait speed for use during post-stroke rehabilitation (Kwakkel et al., 2017; Cheng et al., 2020) and they suggest using the 10-meter walk test (10mWT).

Ten-meter walk test (10MWT)

Following a stroke, approximately 70% of individuals older than 65 regain independent gait within 6 months; however, only 30% of patients achieve gait speeds above 0.8 m/s during inpatient rehabilitation (Hosoi et al., 2023). One of the most popular techniques for determining gait ability is the 10-meter walking test (10MWT), which is simple and quick to administer both in a lab setting and a clinical setting (Hosoi et al., 2023) and has been regarded as trustworthy in numerous reports (Andersen and Kristensen, 2019; Cheng et al., 2021; Hosoi et al., 2023). Furthermore, as the 10MWT has been demonstrated to be connected with motor function, health-related quality of life, and predictors of mortality, recording changes in gait speed is regarded very essential (Fulk et al., 2017; Dorsch et al., 2021; Hosoi et al., 2023).

Single-leg stance (SLS) test

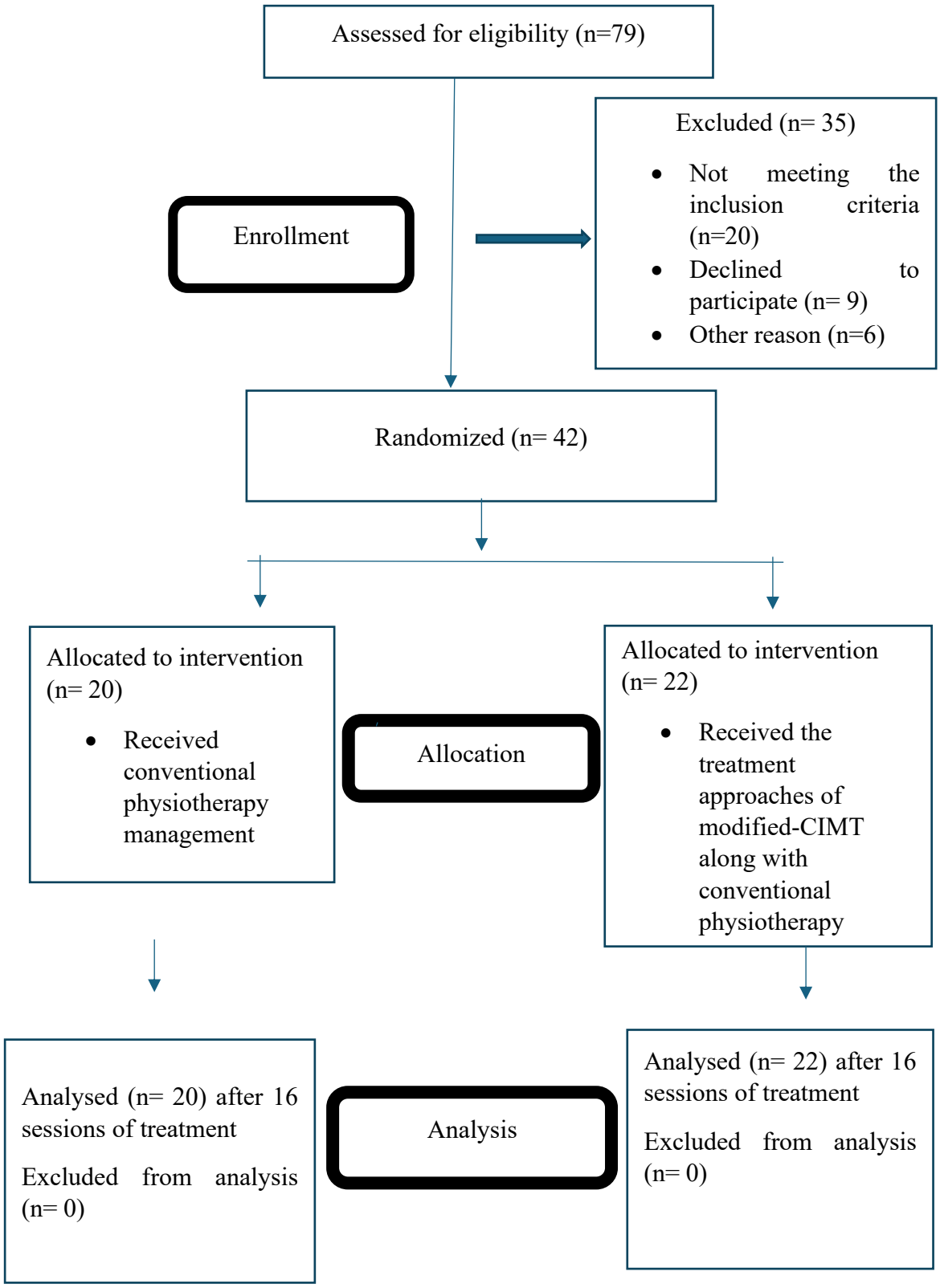
Loss of balance is one of the most common aftereffects of a stroke, leading to increased fall risk. It is found among stroke patients (Subramaniam, Hui-Chan and Bhatt, 2014; Perez-Cruzado, Gonzalez-Sanchez and Cuesta-Vargas, 2018). The single-leg stance (SLS) is a convenient tool that can be used to evaluate the ability of those poststroke and healthy to maintain a standing balance (Langhammer, Lindmark and Stanghelle, 2014; Al-Jarrah et al., 2014; Nott, Neptune and Kautz, 2014; Perez-Cruzado, Gonzalez-Sanchez and Cuesta-Vargas, 2018).

Chapter-iii Methodology

3.1 Study design:

This study looked into the effectiveness of modified Constraint-Induced Movement Therapy (mCIMT) in treating stroke patients with gait dysfunction. The investigator used a single-blind randomized clinical study design in stroke patients (ischemic and hemorrhagic). Randomized clinical trials are the gold standard to assess the efficacy of interventions. In this design, participants are randomly allocated to an intervention (or experimental) group versus a control group (Akobeng, 2005). According to Friedman, Furberg and DeMets (2010, p. 2) a clinical trial is an 'observation of individuals in which interventions are administered to evaluate the effect (s) and estimate the value of the intervention(s) by comparing outcomes in a control group of individuals not receiving the intervention(s). And with comparison of treatments, randomisation is the only reliable way to allow for those confounders. The benefit of well-conducted RCTs is well accepted to inform treatment effectiveness for society in the end (James, 2015). As per the definition, a randomized clinical trial design was more appropriate and best suited than other designs due to randomization, blinding, minimizing selection bias, and being more practical and relevant for experimental research. Therefore, the researcher conducted a randomized clinical trial design to meet the study's aim.

3.2 CONSORT flowchart



3.3 Study site:

Stroke Patients attending the Neurology and Stroke Rehabilitation Unit, Department of Physiotherapy, Centre for the Rehabilitation of the Paralysed (CRP), Savar, Dhaka-1343, were included in the study.

3.4 Study population:

This study involved patients diagnosed with stroke in the Neurology and Stroke rehabilitation units at the Centre for the Rehabilitation of the Paralysed (CRP), Savar, Dhaka—1343.

3.5 Data collection period:

The study was conducted from 1st June 2024 to 31st May 2025, and the duration of data collection was from 1st January 2025 to 31st March 2025, approximately 3 months from initial recruitment through to the final dissemination of results.

3.6 Sample size:

The sample size of the present study was calculated by G Power software version 3.1.9.4. Using a previously reported study's effect size of 0.4 (Abdullahi et al., 2021). Forty-four patients were calculated according to an analysis with an alpha value of 0.05 and a power of 0.8. However, the research was conducted for academic purposes, which resulted in time limitations. Therefore, 42 patients were selected for this study and 22 patients in the experimental group and 20 patients in the control group.

3.7 Sampling Technique:

The sample was obtained using stratified random sampling by the researcher. Stratified random sampling is one type of probability sampling (Nguyen, 2021). Stratified randomization is a procedure performed in two stages where patients enrolled in a clinical trial are first allocated to strata defined by certain clinical characteristics that can affect the risk of outcome. Thereafter, the subjects are assigned to treatment within each stratum according to varying schedules for randomization (Etikan and Bala, 2017). For the present study, the researcher's interest was in stroke patients with gait

dysfunction. The patients fulfilling the inclusion criteria were picked up as the test sample in the present study from the Neurology unit and Stroke Rehabilitation unit of CRP, Savar. The study subjects selected were categorized into several subgroups: ischemic stroke, hemorrhagic stroke, age ≥18 years, Berg balance scale score ≥35, and ability to walk at least 8 meters with or without assistance. Following this, sealed numbered envelopes were mixed and divided into two groups (experimental and control). Forty-two such patients participated in the present study. 22 patients were treated by the experimental group in the treatment protocol of modified-CIMT and conventional physiotherapy and 20 patients by the control group in the treatment of conventional physiotherapy only.

3.8 Inclusion criteria:

- History of stroke (either ischemic or hemorrhagic) with motor impairment of the lower extremity. (Abdullahi et al., 2021)
- Age ≥18 years, including both male and female. (Aloraini, 2022)
- Patients should have a minimum of 15 degrees of knee flexion in the injured leg. (Umar and Abdullahi, 2020)
- Capable of comprehending written and/or spoken instructions. (Marklund et al., 2023)
- Patients can have ≥15 degrees of active hip flexion in the injured leg.
- A Berg balance scale (BBS) score of ≥35. (Aloraini, 2022)
- Walking a minimum of 8 meters, 3 times per day – with or without an aid and with or without the support of another. (Pereira et al., 2022)
- Well adhere to the therapeutic session. (Aloraini, 2022)

3.9 Exclusion criteria:

- Pain in the more-affected lower extremity (≥6 on a 10-point visual analog scale). (Umar, Adegoke and Dada, 2024)
- Modified Ashworth Scale >2. (Umar, Adegoke and Dada, 2024)
- Individuals who have neurological disorders other than stroke that cause balance issues, such as Parkinson's disease, inner ear dysfunction, or cerebellar damage. (Chavan and Raghuveer, 2024)

- Patients with lower limb deformity before stroke. (Abdullahi et al., 2021)
- Individuals with uncontrolled hypertension, symptomatic heart failure, or unstable angina. (Chavan and Raghuveer, 2024)
- Physician determined unstable cardiovascular conditions. (Chavan and Raghuveer, 2024)
- The patient is known to have organ dysfunction, such as heart, renal, and lung failure. (Chavan and Raghuveer, 2024)

3.10 Data collection procedure:

The data collection procedure was conducted by assessing the patient, initial recording and final recording. After screening the patients at the department, they were evaluated by a qualified physiotherapist. First, the data collector told the participant about the consent form. The treatment period consisted of sixteen sessions for each subject. The researcher randomly assigned all of the participants to one of two treatment groups: a control (C1: 20), and an experimental (E1: 22). The treatment group underwent conventional physiotherapy combined with modified Constraint-Induced Movement Therapy (mCIMT), whereas the control group was treated with conventional physiotherapy only. Data were gathered through pre-test, intervention and post-test sessions by a questionnaire form designed by the researcher under the supervisor's guidance and the expert neuro-physiotherapist. It was composed of a timed and go test, 10-meter walk test, single leg stance test and functional ambulation category. Pretests were administered prior to the intervention and post-test data were obtained using a similar approach. The data collection process took place in the presence of a qualified physiotherapist to minimize bias. Specific tests were performed for statistical analysis after the data collection.

3.11 Data collection tools:

3.11.1 Questionnaire:

A semi-structured questionnaire was used in this context because it combines the structure of pre-defined (sociodemographic part), close-ended questions with a timed up and go test to assess functional mobility, a 10-meter walk test to assess walking speed, a single-leg stance test to measure static balance, a functional ambulation

category to explore functional ambulation ability, and each question was formulated to find out the efficacy of modified Constraint Induced Movement Therapy (mCIMT) on patients with gait dysfunction in the stroke population.

3.11.2 Outcome measurement tools:

Ten-meter walk test (10MWT)

Walking speed is a standardized measure of functional mobility, commonly used in both clinical and research settings. It is a crucial component of the human walk (Chavan and Raghuveer, 2024). The 10m walk test (10MWT) is a typically used clinical foreground test to assess gait speed for patients (van de Port et al., 2008). Additionally, the 10MWT can measure gait speed in healthy older persons. Therefore, the 10MWT is recommended to achieve the most reliable clinical evaluation of walking speed (Chavan and Raghuveer, 2024).

Timed up and go test (TUG)

In this simple functional mobility test, the patient must sit, stand, walk three meters as quickly as possible, turn 180 degrees, walk back, and sit down again. The time between releasing the chair's backrest and touching it again after walking is measured. The analysis should be conducted at the optimal time of three trials. This exam assesses the risk of falls and monitors patient mobility changes (Bonnyaud et al., 2015; Menezes-Oliveira et al., 2021).

Single leg stance (SLS) test

The Statical Posture and Balance Control Test was the Single Leg Stance (SLS) Test. Single limb stance is 40% of the gait cycle and a very important position when someone is walking. Although walking is a dynamic movement and a single-leg stance is a static posture, the stability processes are nearly the same. The SLS Test is a balanced assessment frequently performed in clinical settings to detect neurological and musculoskeletal problems. The test is with open eyes and hands on the hip. They should stand on one leg without any help for as long as possible, with the time in seconds taken from the moment one foot lifts from the ground to the moment it returns to the floor, the standing foot is raised from the floor, or one hand leaves the sides.

Functional ambulation category (FAC):

The Functional Ambulation Categories (FAC) test, which has a maximum score of 5, assesses the kind of ambulation and the degree of human help needed when walking, regardless of whether a patient uses a personal assistive technology or not. An assessor administers the FAC by having the subject perform multiple tasks and then briefly observing their capacity to walk, assigning a score between 0 and 5. The FAC is easy to administer, involves only a short interview and observation, and imposes little burden on patients. Additionally, no equipment is required to be provided with the use of the scale.

3.12 Intervention:

3.12.1 Treatment protocol for the control group:

1. Therapeutic positioning:

- Posture correction
- Skilled facilitation includes: lateral pelvic shift
- Active lying
- Active sitting
- Active Standing

2. Range of motion/ flexibility training

- Selective movement of the whole body
- Guided movement
- Dissociative movement

3. Stretching

- Stretching exercise
- Ankle-foot strategic exercise in lying

4. Sensory motor activity

- Sensory stimulation
- Neuromuscular reeducation
- The sensory-motor performance
- Proprioception training

5. Strength training

- Isometric training
- Trunk control exercise
- Pelvic tilting exercise
- Abductor and adductor muscle strengthening exercise
- Core strengthening exercise
- Half squatting practice
- Full squatting practice
- Lunge exercise practice
- Active facilitatory exercise in lying
- Bridging exercise followed by modified bridging

6. Mobility training

- Foot preparation
- Calf muscle activation
- Abdominal muscle activation
- Gluteal muscle activation
- Facilitation of hip flexion

7. Balance and coordination training:

- Postural control
- Trunk and pelvic stabilization exercise
- Weight-bearing exercise in standing
- Static and dynamic balance training
- Dynamic standing balance practice
- Weight-bearing exercise

- Weight-shifting exercise
- Controlled weight shifting
- Balance training (heel-to-toe, balance board)

8. Gait training:

- Stepping practice
- Target stepping
- Side-stepping practice
- Backward walking
- Gait training on the parallel bars
- Stairing practice

3.12.2 Treatment protocol for the experimental group:

Table 1: Treatment protocol of the experimental group:

(using a gaiter on the unaffected leg)

Treatment	**Description**	**Dose and duration**	**Progression**
1. Knee control on a step. (Chavan and Raghuveer, 2024) (Figure 1)	To start, place the affected feet on a stair step while holding on to the rail and to a cane or the caregiver's hand. Lean forward and then stand up completely. Again, lean forward slightly, and lower down, slowly, and under control to the start position.	15-20 repetitions X 1 set (90-120 seconds), in each session, 4 times a week for 4 weeks.	Progress without hand support, changing the stair height, the distance between feet and stairs, and the duration of each trial.

2. Sit-to-stand transfer by using an appropriate chair. (Zhu et al., 2016) (Figure 2)	Begin by sitting on a chair. Without using hands for support, stand up and then sit back down. Make sure each movement is slow and controlled.	15-20 repetitions X 1 set (90-120 seconds), in each session, 4 times a week for 4 weeks.	Progress by increasing the number of sit/stand positions a patient can do in 1 minute.
3. Single-leg cycling. (Billinger et al., 2010) (Figure 3)	Cycling with only the more affected leg.	15-20 repetitions X 1 set (90-120 seconds), in each session, 4 times a week for 4 weeks.	Progress by increasing the speed and time.
4. Ball kicking (Chavan and Raghuveer, 2024) (Figure 4)	The therapist kicks the ball to the patient, who places his foot on top of it and kicks it back.	15-20 repetitions X 1 set (120- 180 seconds), in each session, 4 times a week for 4 weeks.	Progress is made by increasing repetition or decreasing the duration of the task.

Note: 1 minute rest between each item.

Figure 1: Knee control on a step

Figure 2: Sit-to-stand transfer by using an appropriate chair.

Figure 3: Single-leg cycling

Figure 4: Ball kicking

3.13 Data analysis:

The data were entered into Statistical Package for Social Science (SPSS) Version 25 and a Microsoft Excel worksheet 22 for analysis. A descriptive and inferential statistical analysis may be conducted. The statistical decision will be made according to the nature of the data, the objective, and expert opinion.

3.14 Informed consent:

The individual utilized an information sheet and consent form in both English and Bengali to secure participants' consent. The initial step involved obtaining participation consent from each individual. All participants provided signed informed consent. The participants retained the right to decline to answer any question, to withdraw their consent, and to cease participation at any point during the study. The individual also clarified that should the participants choose to withdraw from the study, it would not impact their treatment in the physiotherapy department, and they would continue to have access to the same facilities. All individuals had the opportunity to engage in discussions with the CRP administration regarding their concerns.

3.15 Ethical consideration:

A few ethical considerations were maintained: A research proposal was submitted to the physiotherapy department of BHPI. The faculty member approved the research proposal, and permission was secured from the research project supervisor and the course coordinators prior to conducting the study. The dissertation proposal and methodology received approval from the Institutional Review Board (IRB), and permission was obtained from the relevant authority of the ethical committee at the Bangladesh Health Professions Institute (BHPI). The entire process of this study was conducted in accordance with the guidelines set forth by the Bangladesh Medical Research Council and the World Health Organization. Once more, permission was obtained from the relevant agencies prior to data collection to ensure the safety of the participants. The investigator maintained strict confidentiality regarding the patients' diseases and therapies. The rights of the subjects were safeguarded, and accountability for any inquiries regarding the study rested with the investigator.

Chapter-iv Results

This research examines the efficacy of modified Constraint-Induced Movement Therapy (mCIMT) in stroke patients experiencing gait impairment. Twenty patients were assigned to the control group and twenty-two to the experimental group, resulting in a total of forty-two patients. The findings indicated a significant improvement in the gait of stroke patients following modified Constraint-Induced Movement Therapy (mCIMT) intervention. The experimental group exhibited notable enhancement relative to the control group. These findings indicate that the inclusion of this training technique in rehabilitation programs for stroke might benefit stroke patients with walking difficulties in recovering faster and achieving a better functional outcome. The findings are reported in the following:

4.1 Baseline characteristics of the participants:

The current study involved 42 patients to examine the efficacy of mCIMT on gait dysfunction in the stroke population. The control group consisted of 20 patients, whereas the experimental group consisted of 22 patients. The principal conclusions of the research are detailed herein.

Table 2: Age of the participants

Variable	Control group (Mean with standard deviation)	Experimental group (Mean with standard deviation)	P value
Age	51.15(±12.631)	50.82(±12.783)	.939

Table 2 presents the baseline characteristics in the experimental with those in the control group. Moreover, there was no significant difference between the two groups at baseline. Within all 42 subjects, age ranged between 18-75. In the control group n=20, the average age was 51.15 and the maximum age was 66 and the minimum age was 18. In the experimental group, n=22, the average age was 50.82, and the maximum age was 75, and the minimum age was 19.

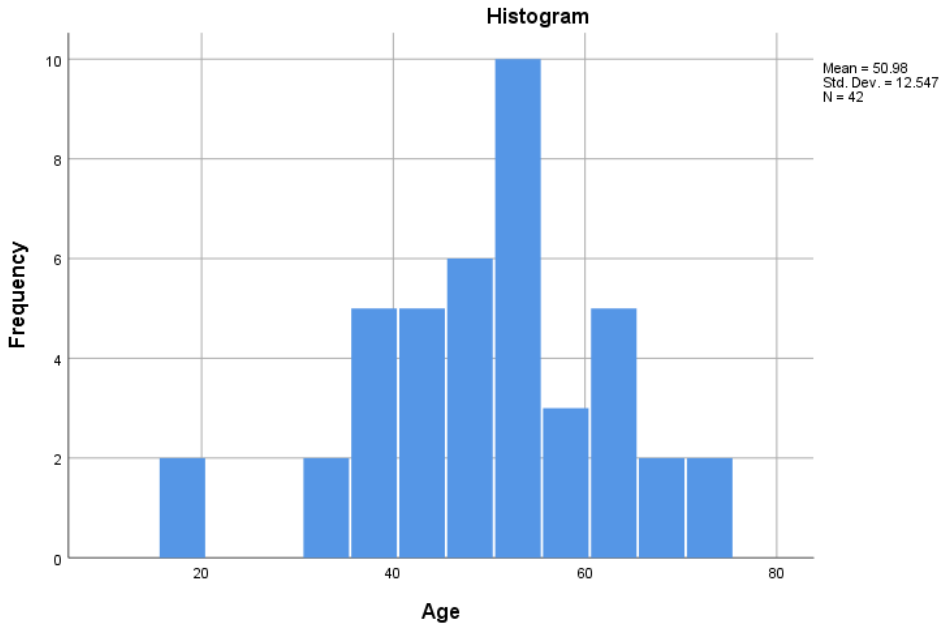


Figure 5: Age of the participants

Table 3: Socio-demographic information of both the experimental and control groups

Variables	Control group n (%)	Experimental group n (%)	P value
Gender			
Male	18(90%)	16(72.7%)	.160
Female	2(10%)	6(27.3%)	
Marital status			
Married	19(95%)	18(81.8%)	.172
Unmarried	1(5%)	1(4.5%)	
Divorce	0	1(4.5%)	
Widow	0	2(9.1%)	
Living area			
Rural	7(35%)	13(59.1%)	.039
Semiurban	5(25%)	7(31.8%)	
Urban	8(40%)	2(9.1%)	
Educational status			
No formal education	4(20%)	6(27.3%)	.248

Primary education	1(5%)	5(22.7%)	
Secondary education	8(40%)	4(18.2%)	
Higher secondary education	0	3(16.6%)	
Bachelor's degree or above	7(35%)	4(18.2%)	
Occupation			
Housewife	2(10%)	5(22.7%)	.091
Garments worker	0	1(4.5%)	
Driver	1(5%)	2(9.1%)	
Businessman	4(20%)	5(22.7%)	
Others	13(65%)	9(40.9%)	

Gender Distribution among participants:

In the experimental group, 72.7% of the patients were male and 27.3% were female, among 42 subjects. In the control group, males were 90%, while females were 10%.

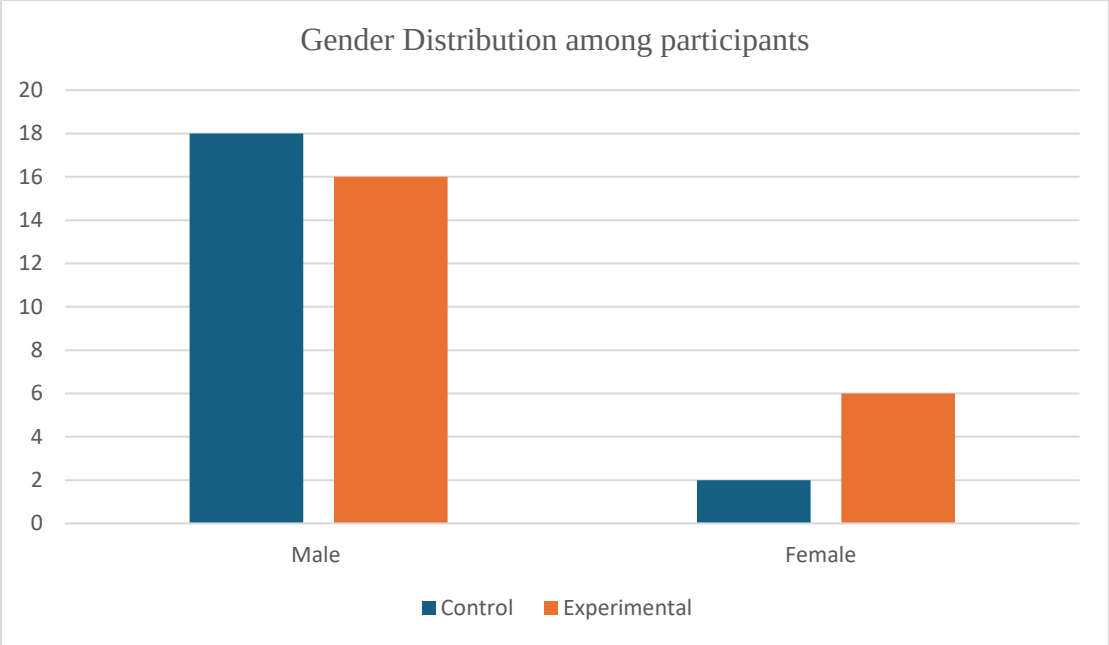


Figure 6: Gender Distribution among participants

Marital status

In the experimental group, 81.8% of participants were married, 4.5% were unmarried, 4.5% were divorced, and 9.1% were widows. In the control group, 95% were married, and 5% were unmarried.

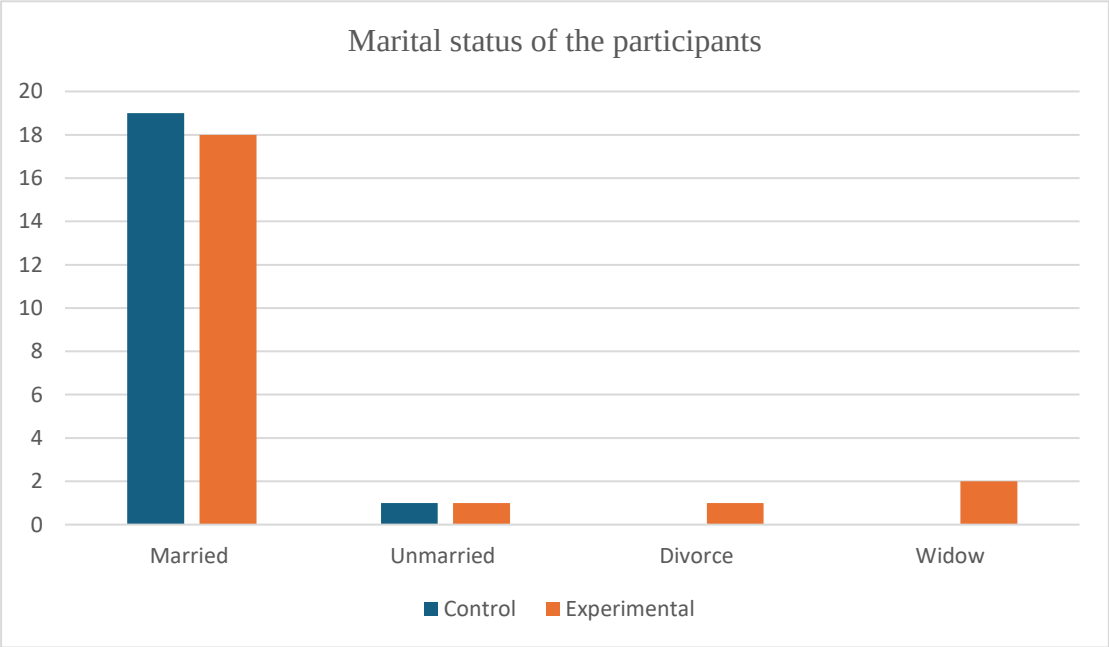


Figure 7: Marital status of the participants

Living area

The research was performed on 42 patients suffering from stroke. Of these, the experimental group included 59.1% living in rural areas, 31.8% in semiurban areas and 9.1% in urban areas. Of the control group, 35% resided in the rural area, 25% in the semiurban area, and 40% in the urban area.

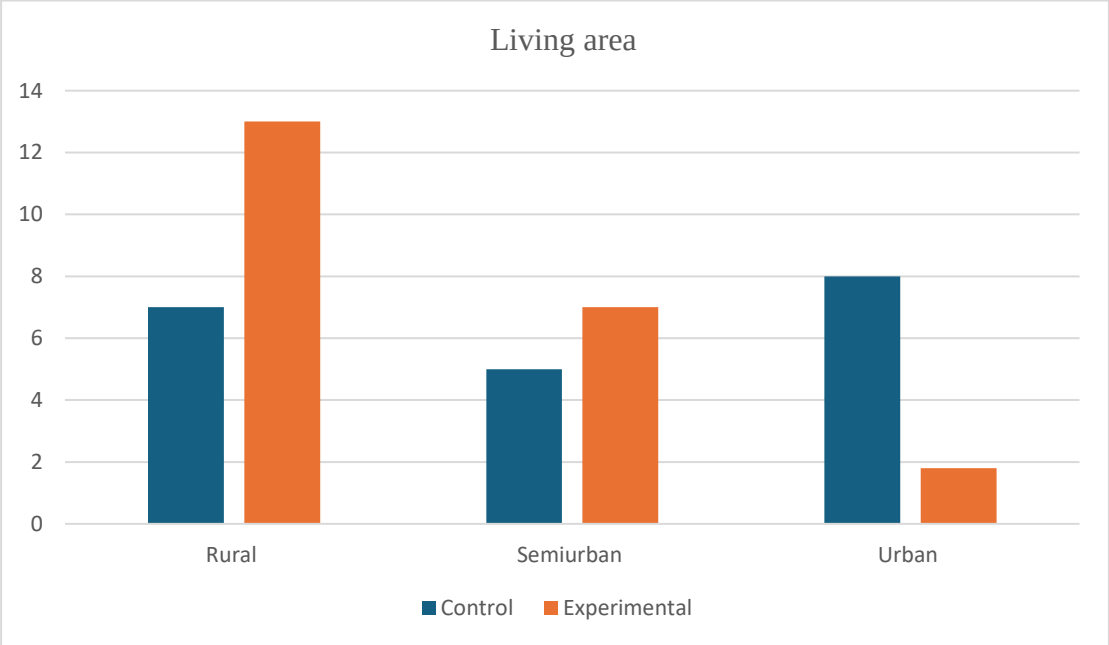


Figure 8: Living area of the participants

Educational qualification

Out of the 42 of total patients in the experimental group, 27.3% of patients were uneducated, 22.7% patients had taken primary education, 18.2% had taken secondary education, 16.6% had taken higher secondary education, and 18.2% were graduates and above. In the control group, 20% and 5% had no education and primary level of education, respectively, while 40% and 35% of participants completed secondary and university education, respectively.

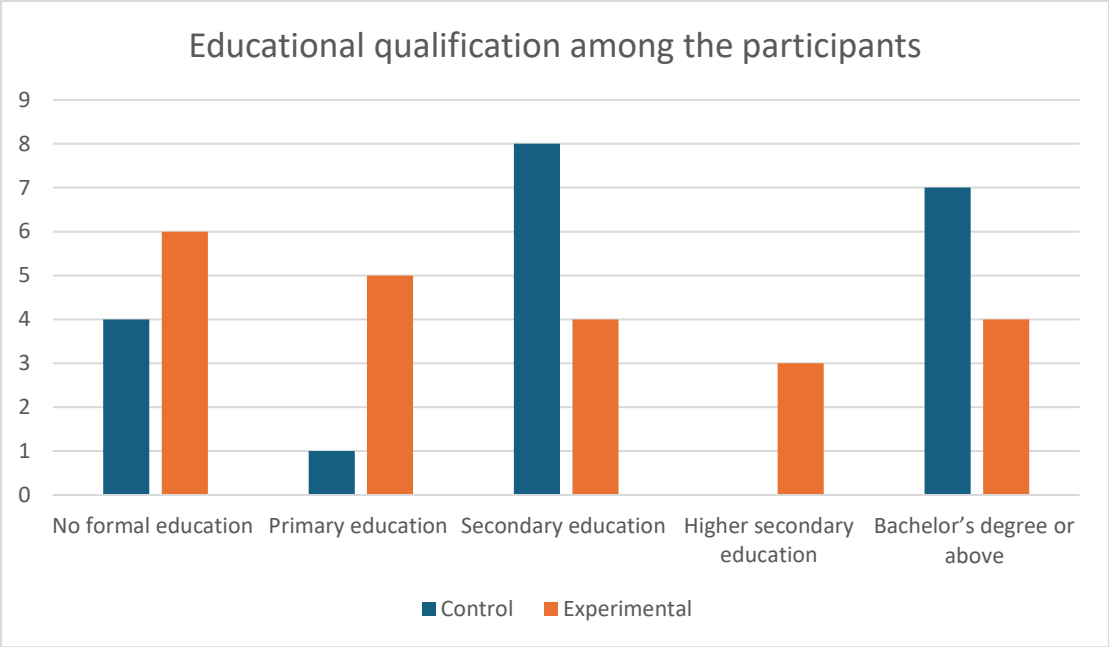


Figure 9: Educational qualification among the participants

Occupation

Among 42 stroke patients, in the experimental group, 22.7% of patients were housewives, 4.5% of patients were garment workers, 9.1% of patients were drivers, 22.7% of patients were businessmen and 40.9% of patients were in other occupations. In the control group, 10% of patients were housewives, 5% of patients were drivers, 20% of patients were businessmen and 65% of patients were in other occupations.

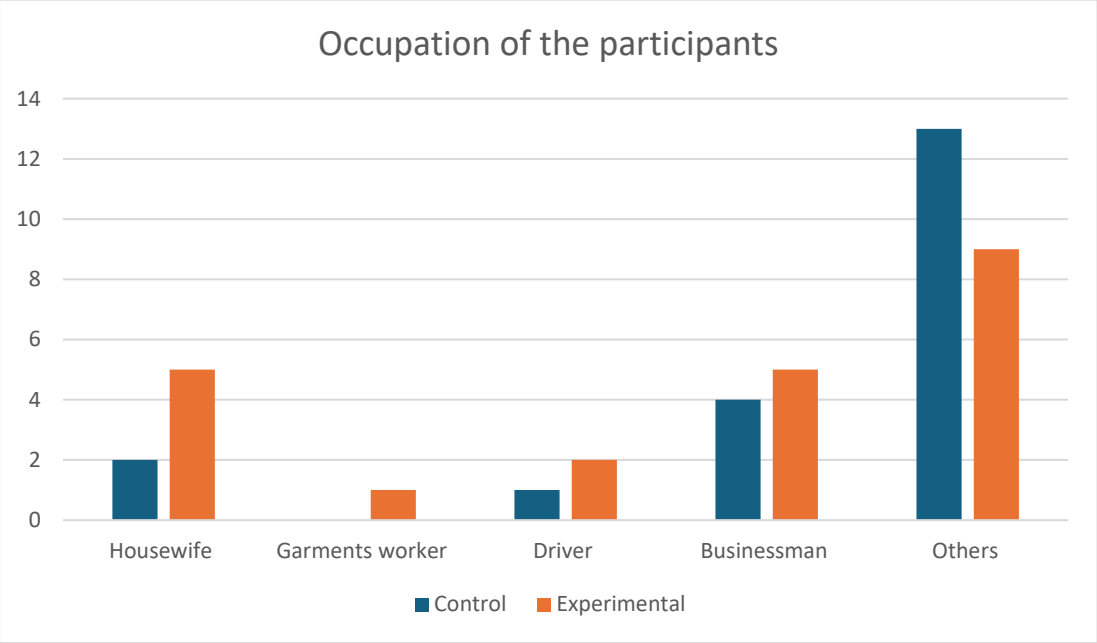


Figure 10: Occupation of the participants

4.2 Stroke-related variables

Table 4: Type of stroke

Variables	Control group n (%)	Experimental group n (%)	P value
Ischemic	15(75%)	16(72.7%)	.869
Hemorrhagic	5(25%)	6(27.3%)	

Among the total 42 patients enrolled in the study, the diagnostic distribution revealed that 31 individuals were diagnosed with ischemic stroke, whereas the remaining 11 patients experienced hemorrhagic stroke. In the experimental group, comprising 22 participants, 72.7% were diagnosed with ischemic stroke (n=16), while in the control group, consisting of 20 participants, 75% had ischemic stroke (n=15). On the other hand, 27.3% were diagnosed with hemorrhagic stroke (n=6) in the experimental group, while in the control group, 25% had hemorrhagic stroke (n=5).

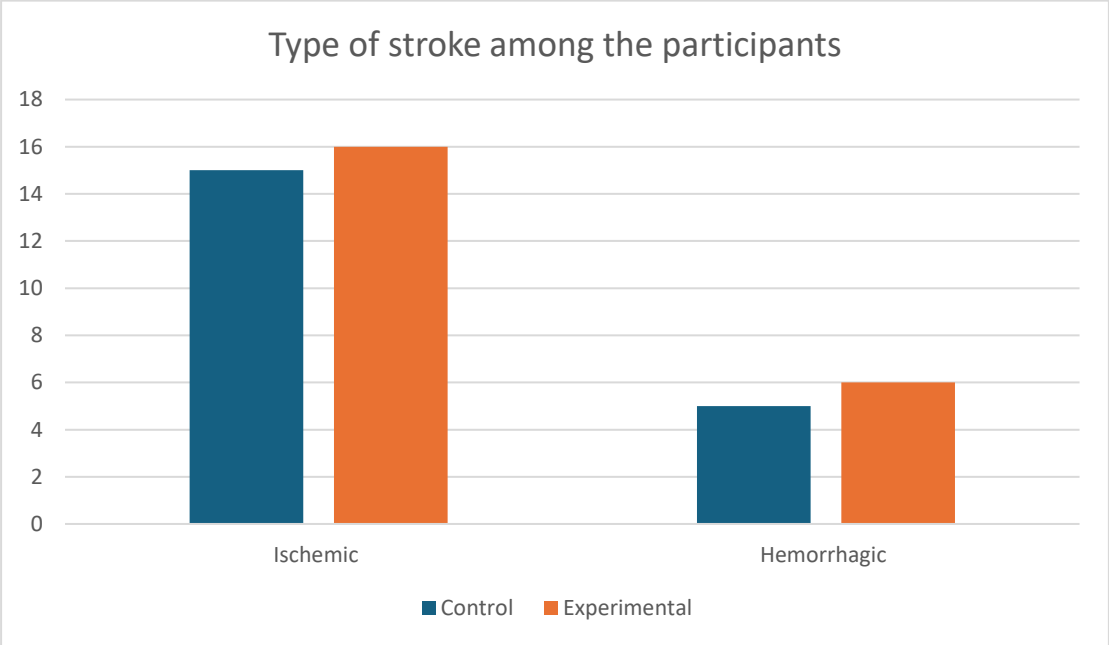


Figure 11: Type of stroke among the participants

Table 5: Time since the stroke of taking the intervention in both groups

Variables	Control group n (%)	Experimental group n (%)	P value
1 month or above	9(45%)	12(54.5%)	.330
6 months or above	6(30%)	7(31.8%)	
1 year or above	5(25%)	3(13.6%)	

In examining the timing of interventions since the occurrence of stroke within both the experimental and control groups, distinct patterns emerge among the participants. The majority of individuals in both groups initiated interventions after 1 month or more post-stroke. In 22 the experimental group, 54.5% of participants fell into this category, while the control group had a slightly lower percentage at 45%. A large percentage of participants in each group initiated interventions later than 6 months from the stroke onset, 31.8% in the experimental period and 30% in the control period. Additionally, 13.6% of experimental and 25% of control participants began an intervention 1 or more years post-stroke. Time of intervention is important for evaluating treatment efficacy and for estimating the effect of treatments in patients, which is helpful for a full understanding of the results of the trial.

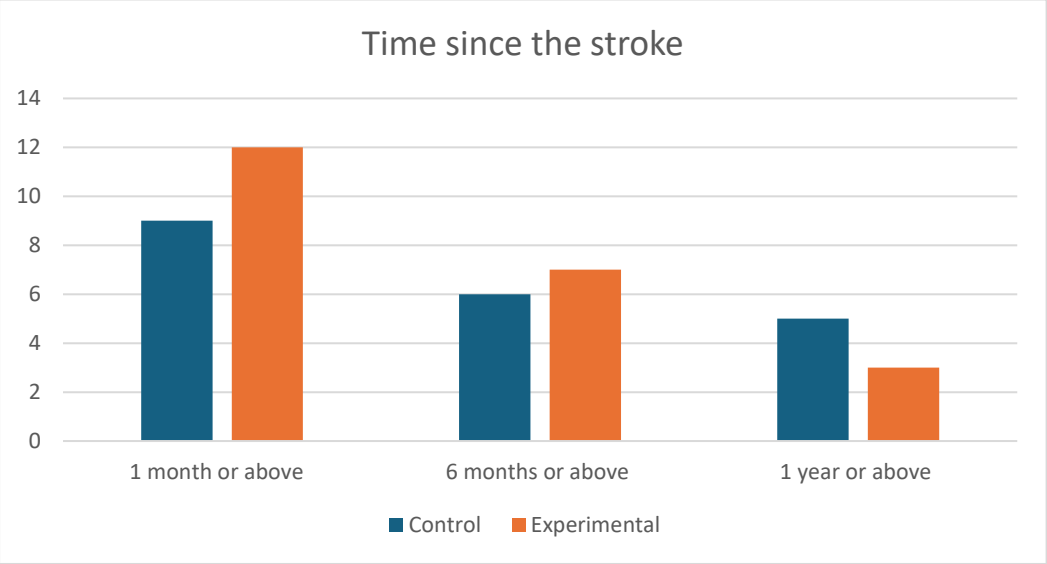


Figure 12: Time since the stroke of taking the intervention among the participants

Table 6: Family history of stroke

Variables	Control group n (%)	Experimental group n (%)	P value
Yes	5(25%)	6(27.3%)	.869
No	15(75%)	16(72.7%)	

Of the 42 patients in the present study, the diagnosis distribution was as follows: 11 cases had a family history of stroke, and 31 cases had no family history of stroke. Family history of stroke was positive in 6 (27.3%) in the experimental group and 5 (25%) in the control group families in family members of 22 and 20 patients, respectively. However, 72.7% of subjects did not have a family history of stroke (n=16) in the experimental group and 75% of subjects did not have a family history of stroke (n=15) in the control group.

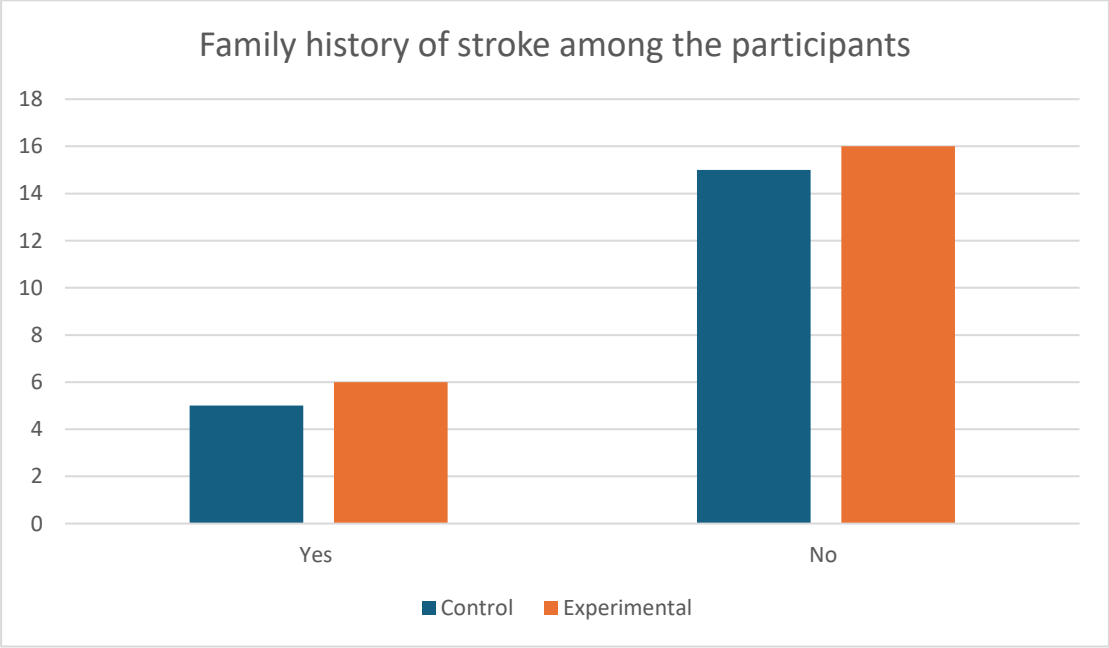


Figure 13: Family history of stroke among the participants

Table 7: Affected side

Variables	Control group n (%)	Experimental group n (%)	P value
Right	14(70%)	11(50%)	.193
Left	6(30%)	11(50%)	

Among 42 stroke patients, in the experimental group, 50% were right-sided and 50% were left-sided affected. In the control group, 70% were right-sided and 30% were left-sided affected.

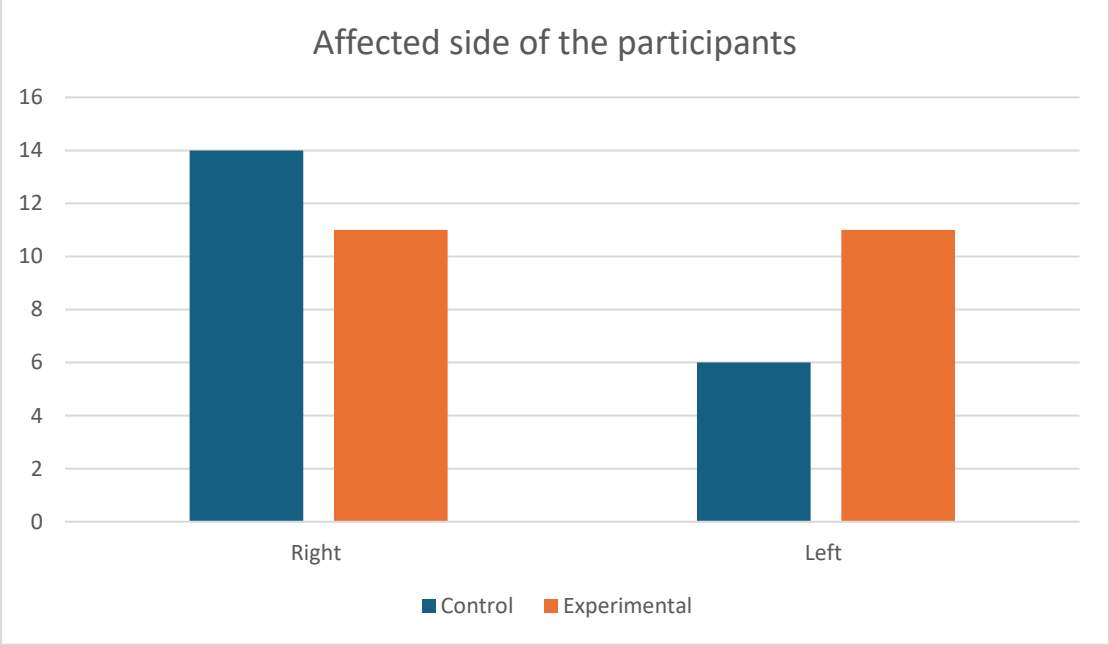


Figure 14: Affected side of the participants

Table 8: Comorbidities with stroke

Variables	Control group n (%)	Experimental group n (%)	P value
Number of comorbidities			
Single	10(50%)	9(40.9%)	.559
Multiple	10(50%)	13(59.1%)	

Stroke-related co-morbidities were assessed among the patients. The survey asked about co-morbidities (hypotension, diabetes mellitus, heart disease, lung disease, and more). In the experimental group, one comorbidity was present in 40.9% (n=9), and more than one was present in 59.1% (n=13). Both single comorbidity and multiple comorbidities were found in 10 (50%) in the control group.

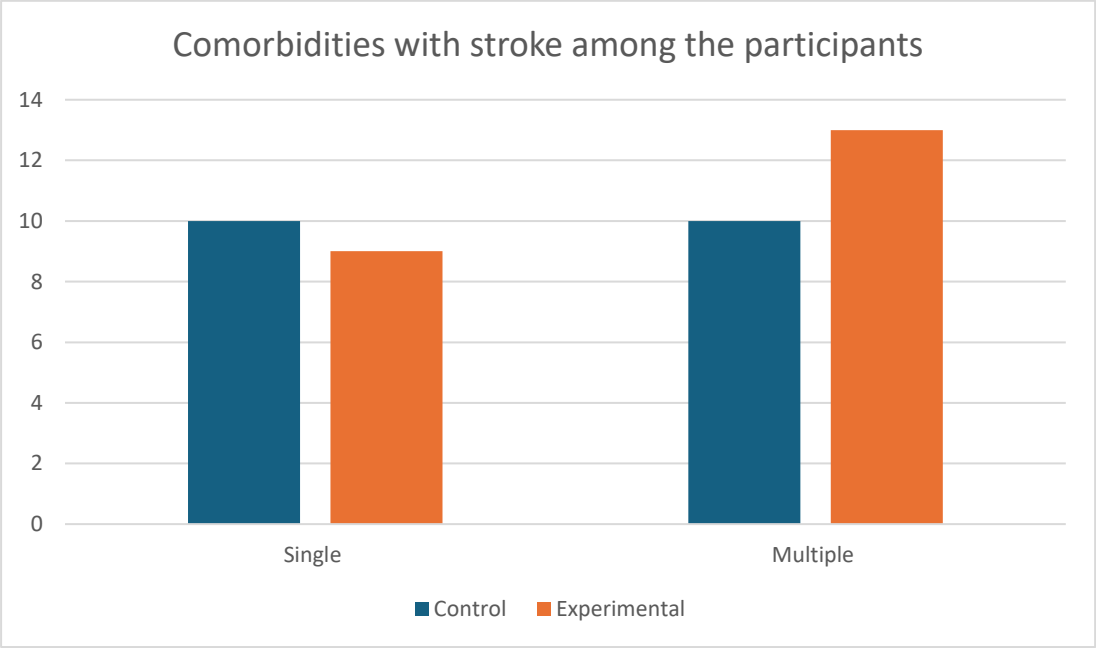


Figure 15: Comorbidities with stroke among the participants

4.3 Inferential Analysis

Q. Is the experimental Timed Up and Go pre-test mean significantly different from the experimental Time Up and Go post-test mean?

1. Hypothesis

H_O = There is no significant difference between the mean of the experimental TUG pretest and the mean of the experimental TUG posttest

H_A = There is a significant difference between the mean of the experimental TUG pretest and the mean of the experimental TUG posttest

2. α value = 0.05

3. Assumption

-Normality test- the Timed Up and Go test score is normally distributed

-Homogeneity (baseline criteria are similar)

-Sample size >30

4. Compute the statistics

- Paired t-test

Table 9: Within-group analysis by Paired t-test for the experimental group of the Timed Up and Go test

Variables	Experimental Pre-test Mean	Experimental Post-test Mean	Mean difference	Paired t-test		
				Observed t value	df	Sig (p-value)
Timed up and go	34.956	21.052	13.905	8.863	21	.000*

*= level of significance (<0.05)

A statistically significant difference in the means is shown in the table (t = 8.863, P =.000), since there is a difference in the means between the two groups. Since the p-value is less than 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted as the result is significant. So that it could be concluded that stroke patients with lower extremity gait dysfunction benefit more after mCIMT.

Q. Is there any difference between the mean of the control Timed Up and Go pre-test and the mean of the control Timed Up and Go post-test?

1. Hypothesis

H_O = There is no significant difference between the mean of the control TUG pretest and the mean of the control TUG posttest

H_A = There is a significant difference between the mean of the control TUG pretest and the mean of the control TUG posttest

2. α value = 0.05

3. Assumption

-Normality test- the Timed Up and Go test score is normally distributed

-Homogeneity (baseline criteria are similar)

-Sample size >30

4. Compute the statistics

- Paired t-test

Table 10: Within-group analysis by Paired t-test for the control group of the Timed Up and Go test

Variables	**Control Pre-test Mean**	**Control Post-test Mean**	**Mean difference**	**Paired t-test**		
				Observed t value	df	Sig (p-value)
Timed up and go	41.657	42.915	-1.258	-1.745	19	.097

The table reveals that there is a significant difference between the means (t = -1.745, p=.097). The null hypothesis is accepted and the alternative hypothesis is rejected as p > 0.05; hence, the result is not statistically significant.

Q. Is there any difference between the Experimental Timed Up and Go post-test mean and the Control Timed Up and Go post-test mean?

1. Hypothesis

H_O = There is no difference between the experimental post-test mean and the control post-test mean for Timed Up and Go.

H_A = There is a difference between the experimental post-test mean and the control post-test mean for Timed Up and Go.

2. α value = 0.05

3. Assumption

- Normality test- the Timed Up and Go test score is normally distributed

-Homogeneity (baseline criteria are similar)

-Sample size >30

4. Compute the statistics

- Independent t-test

Table 11: Between-group analysis by an independent t-test for the experimental group and the control group of the Timed Up and Go test

Variable	Experimental Post-test Mean	Control Post-test Mean	Mean difference	Independent t-test		
				Observed t value	df	Sig (p-value)
Timed up and go	21.052	42.915	-21.863	-2.144	40	.038*

*= level of significance (<0.05)

The table shows that a statistically significant difference exists between the means (t =-2.144, P = .038) and the difference was mainly due to the different means. The null hypothesis is rejected in favour of an alternative hypothesis and the alternative hypothesis is accepted: since the p-value is less than 0.05, the result is significant. For that reason, it can be argued that modified constraint-induced movement therapy (mCIMT) is effective for stroke patients with lower extremity gait disorders.

Q. Is there any difference between the mean of the experimental pre-ten-meter walk test and the mean of the experimental post-ten-meter walk test?

1. Hypothesis

H_O = There is no difference between the experimental pre-ten-meter walk test mean and the experimental post-ten-meter walk test mean

H_A = There is a difference between the experimental pre-ten-meter walk test mean and the experimental post-ten-meter walk test mean

2. α value = 0.05

3. Assumption

-Normality test- the ten-meter walk test score is normally distributed

-Homogeneity (baseline criteria are similar)

-Sample size >30

4. Compute the statistics

- Paired t-test

Table 12: Within-group analysis by Paired t-test for the experimental group of the ten-meter walk test

Variables	Experimental Pre-test Mean	Experimental Post-test Mean	Mean difference	Paired t-test		
				Observed t value	df	Sig (p-value)
Ten-meter walk test	.613	.995	-.382	-6.902	21	.000*

*= level of significance (<0.05)

The table indicates a statistically significant difference between the means (t = -6.902, P =.000) as well as a difference in the actual mean. The alternative hypothesis is accepted and the null hypothesis is rejected because the p-value is less than 0.05, indicating that the result is significant.

Q. Is there any difference between the mean of the control pre-ten-meter walk test and the mean of the control post-ten-meter walk test?

1. Hypothesis

H_O = There is no difference between the control pre-ten-meter walk test and the control post-ten-meter walk test mean

H_A = There is a difference between the control pre-ten-meter walk test and the control post-ten-meter walk test mean

2. α value = 0.05

3. Assumption

-Normality test- the ten-meter walk test score is normally distributed

-Homogeneity (baseline criteria are similar)

-Sample size >30

4. Compute the statistics

- Paired t-test

Table 13: Within-group analysis by Paired t-test for the control group of the ten-meter walk test

Variables	**Control Pre-test Mean**	**Control Post-test Mean**	**Mean difference**	**Paired t-test**		
				Observed t value	df	Sig (p-value)
Ten-meter walk test	.663	.672	-.009	-.286	19	.778

The table indicates a statistically significant difference between the means (t = -.286, P =.778) as well as a difference in the actual mean. The null hypothesis is accepted and the alternative hypothesis is rejected because the p-value is greater than 0.05, indicating that the result is not significant.

Q. Is there any difference between the Experimental ten-meter walk post-test mean and the Control ten-meter walk post-test mean?

1. Hypothesis

H_0 = There is no difference between the experimental ten-meter walk post-test mean and the control ten-meter walk post-test mean**.**

H_A = There is a difference between the experimental ten-meter walk post-test mean and the control ten-meter walk post-test mean**.**

2. α value = 0.05

3. Assumption

- Normality test- the Timed Up and Go test score is normally distributed

-Homogeneity (baseline criteria are similar)

-Sample size >30

4. Compute the statistics

- Independent t-test

Table 14: Between-group analysis by an independent t-test for the experimental group and the control group of the ten-meter walk post-test

Variables	**Experimental Post-test Mean**	**Control Post-test Mean**	**Mean difference**	**Independent t-test**		
				Observed t value	df	Sig (p-value)
Ten-meter walk test	.995	.672	.323	2.260	40	.029*

*= level of significance (<0.05)

The table indicates a statistically significant difference between the means (t = 2.260, P =.029) as well as a difference in the actual mean. The alternative hypothesis is accepted and the null hypothesis is rejected because the p-value is less than 0.05, indicating that the result is significant. Therefore, it may be said that patients with stroke who have lower extremity gait dysfunction benefit from modified constraint-induced movement therapy (mCIMT).

Wilcoxon signed-rank test for single limb stance for the affected limb of the experimental group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done within-group

Table 15: Within-group analysis by the Wilcoxon signed-rank test for the experimental group of the single limb stance (affected limb) test

				Test statistics (Wilcoxon signed-rank test)	
	N	Mean rank	Sum of ranks	Based on negative ranks Z	Asymp. Sig (2-tailed) P
Pre and post-single limb stance for the affected limb score for the experimental group	22				
Negative ranks	0	.00	.00	-4.110	.000*
Positive ranks	22	11.50	253.00		
Ties	0				
Total	22				

*= level of significance (<0.05)

A table was presented with the participants' scores on the affected limb (experimental group) on single limb stance before (pre-test) and after (post-test) training. The table illustrates that 22 ranks are positive and 0 ranks are negative. No ties exist in the test of the ranks, which means the pre-test and post-test scores are not the same. Z=-4.110 and

p=0.000 mean that we can reject the null hypothesis. The Wilcoxon signed-rank test, which was used to compare the table's final test data, showed that the 16-session experimental treatment session was significantly effective on stroke patients with gait dysfunction.

Wilcoxon signed-rank test for single limb stance for the affected limb of the control group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done within-group

Table 16: Within-group analysis by the Wilcoxon signed-rank test for the control group of the single limb stance (affected limb) test

				Test statistics (Wilcoxon signed-rank test)	
	N	Mean rank	Sum of ranks	Based on negative ranks Z	Asymp. Sig (2-tailed) P
Pre- and post-single limb stance (affected limb) score for the control group	20				
Negative ranks	0	.00	.00	-3.832	.000*
Positive ranks	19	10.00	190.00		
Ties	1				
Total	20				

*= level of significance (<0.05)

The table presented the scores for the affected limb at the single limb stance condition of the control group in pre-test and post-test times. From the table, there were 19 positive ranks and 0 negative ranks. A draw occurs in the remaining positions when the pre-test equals the post-test score. Z=-3.832 and p=0.000 both mean that it is significant. Comparing the stroke patients with gait dysfunction in the stroke patients of the 16-session standard therapy group, the control group exhibited a statistically significant improvement when analyzed by the Wilcoxon signed-rank test at the final test statistics for the table.

The single limb stance test for the affected limb was performed between the experimental and the control group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done between-group

Table 17: Between-group analysis by the Mann-Whitney U score for the experimental group and the control group of the single limb stance (affected limb) test

	Category of Participants	N	Mean rank	Sum of ranks	Mann-Whitney U score	P Sig (2-tailed)
Difference of the single limb stance test (affected limb) between Experimental and control group	Experimental	22	24.27	534.00	159.000	.124
	Control	20	18.45	369.00		

A comparison of the experimental group and the control group in the single limb stance test with the affected limb was presented in the table. The experimental group's mean rank was 24.27, while the control group was 18.45, as seen in the table. The

experimental group's rank total is 534.00, whereas the control group's is 369.00. The alternative hypothesis is rejected and the null hypothesis accepted based on the p-value of.124 and the Mann-Whitney U score of 159.000. Consequently, at the 5% level of significance, the test is not significant. This indicates that there was no discernible difference between the experimental group's treatment and that of the control group.

Wilcoxon signed-rank test for single limb stance for the unaffected limb of the experimental group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done within-group

Table 18: Within-group analysis by the Wilcoxon signed-rank test for the experimental group of the single limb stance (unaffected limb) test

				Test statistics (Wilcoxon signed-rank test)	
	N	Mean rank	Sum of ranks	Based on negative ranks Z	Asymp. Sig (2-tailed) P
Pre- and post-single limb stance (unaffected limb) score for the control group	22				
Negative ranks	0	.00	.00	-4.107	.000*
Positive ranks	22	11.50	253.00		
Ties	0				
Total	22				

*= level of significance (<0.05)

The table presented the participants' scores of the unaffected limb in the experimental group in the pre-test and post-test of single-limb stance. It can be seen from the table that 22 ranks are positive and 0 are negative. There are no ties in the remaining ranks, indicating that the pre-test and post-test scores are not equal. Z=-4.107 and a p-value of 0.000 both indicate significance at the 5% level of significance. According to the Wilcoxon signed-rank test, which was used to analyze the final test data in the table, there was a statistically significant improvement in the 16th experimental session for the stroke patients with gait disturbance in the experimental group.

Wilcoxon signed-rank test for single limb stance for the unaffected limb of the control group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done within-group

Table 19: Within-group analysis by the Wilcoxon signed-rank test for the control group of the single limb stance (unaffected limb) test

				Test statistics (Wilcoxon signed-rank test)	
	N	Mean rank	Sum of ranks	Based on negative ranks Z	Asymp. Sig (2-tailed) P
Pre and post-single limb stance (unaffected limb) score for the control group	20				
Negative ranks	0	.00	.00	-3.920	.000*
Positive ranks	20	11.50	210.00		
Ties	0				

Total	20					

*= level of significance (<0.05)

For the unaffected limb score for the control group, the table showed the participants' comparisons before (pre-test) and after (post-test) of single limb stance. The table shows that there are 20 positive ranks and 0 negative ranks. There are no similarities between the pre-test and post-test, as indicated by the remaining ranks being 0 ties. Z= -3.920 and a p-value of 0.000 both show significance at the 5% level of significance. The control group for the 16-session standard therapy session demonstrated a statistically significant improvement for the stroke patients with gait dysfunction, according to the Wilcoxon signed-rank test, which was used to analyze the table's final test statistics.

The single limb stance test for the unaffected limb was performed between the experimental and the control group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done in between-group

Table 20: Between-group analysis by the Mann-Whitney U score for the experimental group and the control group of the single limb stance (unaffected limb) test

	Category of Participants	**N**	**Mean rank**	**Sum of ranks**	**Mann-Whitney U score**	**P Sig (2-tailed)**
Difference of the single limb stance test	Experimental	22	27.77	611.00	82.000	.001*

(unaffected limb) between Experimental and control group	Control	20	14.60	292.00

*= level of significance (<0.05)

Differences in the single limb stance test for the unaffected limb when comparing experimental and control groups were demonstrated in the table. The average rank of the experimental group = 27.77 and that of the control group = 14.60 as per the table. The total ranks for the experimental group = 611.00 and for the control group = 292.00. The p-value is. 001(for > 0.05) where the Mann-Whitney U score is 82.000 and the null hypothesis is rejected and the alternative hypothesis is accepted. Thus, we can conclude that the test is valid at 5% level of significance. Hence, the researcher concluded that there is a significant difference in the efficacy of these treatments in this case.

Wilcoxon signed-rank test for the Functional ambulation category for the experimental group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done within-group

Table 21: Within-group analysis by the Wilcoxon signed-rank test for the experimental group of the functional ambulation category

				Test statistics (Wilcoxon signed-rank test)	
	N	Mean rank	Sum of ranks	Based on negative ranks Z	Asymp. Sig (2-tailed) P

Pre- and post-the Functional ambulation category for the experimental group	22				
Negative ranks	0	.00	.00	-4.187	.000*
Positive ranks	22	11.50	253.00		
Ties	0				
Total	22				

*= level of significance (<0.05)

Comparison of the experimental group functional ambulation category between pre- and post-tests was presented in the table. We observe from the table that there are 22 positive ranks and 0 negative ranks. There are no similarities between the pre-test and post-test, as indicated by the remaining ranks being 0 ties. Z=-4.187 and a p-value of 0.000 both signify significance at the 5% level of significance. For the 16-session experimental treatment session, the experimental group showed a statistically significant difference for the stroke patients with gait disability, calculated using the Wilcoxon signed-rank test, which analysed the final test data in the table.

Wilcoxon signed-rank test for the Functional ambulation category for the control group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done within-group

Table 22: Within-group analysis by the Wilcoxon signed-rank test for the control group of the functional ambulation category

				Test statistics (Wilcoxon signed-rank test)	
	N	**Mean rank**	**Sum of ranks**	**Based on negative ranks Z**	**Asymp. Sig (2-tailed) P**
Pre- and post-the Functional ambulation category for the control group	20				
Negative ranks	0	.00	.00	-4.058	.000*
Positive ranks	20	10.50	210.00		
Ties	0				
Total	20				

*= level of significance (<0.05)

The subjects in the control group were compared by the level of the functional ambulation category before and after the treatment. From the table we see that there are 20 positive ranks and 0 negative ranks. The rest of the ranks have no ties; thus we know pre-test and post-test scores are not equal. Z=-4.058 and p=0.000 are both evidence of significance at the 5% level of significance. After 16 sessions of the conventional therapy session, the experimental group showed a significant improvement for stroke patients with gait impairment according to the Wilcoxon signed-rank test, which was applied to analyze the final test data in the table.

The functional ambulation category test was performed between the experimental and the control group

This test was calculated to the hypothesis, based on the following assumptions-

- The data were not normally distributed

-The test was done in between-group

Table 23: Between-group analysis by the Mann-Whitney U score for the experimental group and the control group of the functional ambulation category

	Category of Participants	N	Mean rank	Sum of ranks	Mann-Whitney U score	P Sig (2-tailed)
The difference in the functional ambulation category test between Experimental and control group	Experimental	22	23.52	517.50	175.500	.172
	Control	20	19.28	385.50		

A summary of the difference between the groups in the functional ambulation category test is presented in the table. The mean rank of experimental group was 23.52 and control group was 19.28 (as shown in table). Just so happens the experimental group's rank total is 517.50 and the control group's rank total is 385.50. With a Mann-Whitney U score of 175.500 and p=.172 which is greater than 0.05, so alternative hypothesis is rejected and null hypothesis is accepted. Therefore, the test is not statistically significant at the 5% level. Therefore, the author concludes the treatments are not significantly different in this case.

Chapter-v Discussion

5.1 Discussion

The rehabilitation procedures must be both convenient and effective. Numerous studies have conclusively shown that lower limb CIMT enhances gait and balance outcomes following a stroke. Ambulation is essential for autonomy in activities of daily living. It may also aid in restoring patients' self-efficacy, the conviction that they can perform basic tasks following a stroke. The achievement of self-efficacy following rehabilitation can enhance further results (Umar and Abdullahi 2020). The primary objective of the current study is to evaluate the effectiveness of modified Constraint-Induced Movement Therapy (mCIMT) on patients with gait dysfunction in the stroke population.

This study included 22 stroke patients in the experimental group and 20 in the control group. The 22 patients constituted the experimental group and received mCIMT in conjunction with traditional physiotherapy, whereas the subsequent 20 patients formed the control group, which was provided conventional physiotherapy exclusively. Enhancement was noted in both groups across the 16 therapy sessions at the outpatient neurology and stroke rehabilitation unit of CRP, Savar. The structural types of the questionnaire, including the timed up and go test, 10-meter walk test, single leg stance test, and functional ambulation category, were acquired for the functional outcome assessment. The baseline data indicate that at the commencement of the investigation, there was no significant difference between the groups, confirming their homogeneity, a critical aspect of any clinical research.

Chavan and Raghuveer (2024) conducted a study to assess Modified Constraint-Induced Movement Therapy (mCIMT) (group A) and the Motor Relearning Program (MRP) (group B) in sub-acute stroke patients, aiming to ascertain whether intervention is superior. Both therapies demonstrated efficacy in hemiplegic stroke when evaluated against a negative control group in their study. However, there is a paucity of literature demonstrating the advantage of any of the Modified Constraint-Induced Movement Therapy (mCIMT) therapies in comparison to one another.

Age also influences test performance. This study analyzed 42 cases of stroke gait disorder, revealing variations between the two groups: the control group's mean age was 51.15 with a standard deviation of 12.631, whereas the experimental group's mean age was 50.82 with a standard deviation of 12.783. These similar age distributions across studies indicate a consistent representation of stroke patients in terms of age. Of the gender of 42 patients, 34 were male and 8 were female and the percentage of males was 81% and the females was 19%. So, it is interpreted that males are highly affected by stroke in females.

Among the 42 patients, 31 were diagnosed with ischemic stroke, whereas 11 with hemorrhagic stroke, resulting in percentages of 73.8% for ischemic and 26.2% for hemorrhagic types. In the current study, the researcher found that 40.5% of patients had left-side involvement, whereas 59.5% of patients had right-side involvement. As a result, the right side was affected more than the left. Additionally, the duration of stroke was one month or above in 50% of patients out of 42 patients, six months or above in 31% of patients, and 1 year or above in 19% of patients.

Umar, Adegoke and Dada (2024) conducted a study examining the impact of modified Constraint-Induced Movement Therapy (mCIMT) on functionality, mobility, balance, and health-related quality of life (HRQoL) in stroke patients. The study findings indicated that all three treatment regimens significantly affected the health-related quality of life (HRQoL) of hemiparetic stroke patients, as evaluated by the Stroke Impact Scale (SIS). While no substantial differences were noted among the Combined group, Lower Limb group, and Upper Limb group in the areas of strength, emotion, mobility, hand function, and participation, significant disparities were identified in the domains of activities of daily living, memory/thinking, communication, and perceived stroke recovery, as assessed by the visual analogue scale. In this research to determine the effectiveness, the researcher chose four tests based on the objectives. The tests are to assess functional mobility by Timed up and go test, to assess the static balance and ability to stand on an affected leg or sound leg by single-limb stance test, to evaluate walking speed by a 10-m walk test, to investigate the patient's level of ambulation by assessing their functional ambulation category and the amount of human support they need when walking.

The researcher employed a paired t-test for the Timed Up and Go test and an independent t-test for the outcome measures. The paired t-test analysis of the Timed Up and Go test revealed a p-value of 0.000 in the experimental group, which was significant, and a p-value of 0.097, which was not significant in the control group. On the other hand, the independent t-test between-group analysis revealed a significant p-value of 0.038. Accordingly, stroke patients' functional mobility as assessed by the TUG test was considerably enhanced by modified constraint-induced movement therapy (mCIMT). In their study, Umar, Adegoke and Dada (2024) observed enhancements in motor function, mobility, and quality of life among stroke patients who participated in Modified LE CIMT. In a study by Acaroz, Candan and Livanelioglu (2017) conducted a study in which one group underwent mCIMT for two weeks, while the other group received NDT. In the results, mCIMT in the lower leg had a greater impact on motor function than NDT.

The author employed a paired t-test and an independent t-test to analyze walking speed in the 10-Meter Walk Test (10MWT). The paired t-test for the 10-meter walk test revealed a significant p-value of 0.000 and a non-significant p-value of 0.778 in the control group. The independent t-test for inter-group analysis revealed a p-value of 0.029. The walking speeds of stroke patients, evaluated using the 10-meter walk test, showed a significant increase following modified Constraint-Induced Movement Therapy (mCIMT). The initial documentation of this form of the LE-CIT technique applied to a single individual with persistent hemiparesis (published as a case report) was presented by Dos Anjos, Morris, and Taub (2020). The patient in their study underwent LE-CIT for 10 days, and after the protocol, there was an improvement in the patient's balance score along with minor adjustments in walking speed and endurance. Naz et al. (2022) conducted a randomised controlled trial to evaluate the efficacy of the Motor Relearning Program (MRP) in enhancing balance and upright mobility in sub-acute stroke patients. The findings indicated that MRP positively affected post-stroke survivors in the experimental group, who received MRP alongside traditional physical therapy for five days each week over eight weeks.

The Wilcoxon signed-rank test and the Mann-Whitney U test were employed to assess static balance and single-leg standing capability during the single-limb stance test. Within-group analysis revealed that the single-limb stance test for the affected limb,

assessed using the Wilcoxon signed-rank test, demonstrated significant efficacy in both the experimental group (Z = -4.110, p = 0.000) and the control group (Z = -3.832, p = 0.000), thereby affirming the effectiveness of both treatment approaches throughout 16 sessions. Disparities among groups, the Mann-Whitney U test was employed to assess between-group differences, revealing that the disparity between groups was not significant (U = 0.124). This indicates that although improving the static balance in the affected limb in both groups, the addition of modified Constraint-Induced Movement Therapy (mCIMT) did not lead to a significant effect on improving static balance in the affected limb as measured by the single-limb stance test in stroke patients. Candan and Livanelioglu (2019) demonstrated that strength and quality of life enhancements occurred in both groups across all treatment periods ($p<0.01$). The paratic lower limb strength showed greater improvement in the mCIMT group throughout the total treatment period ($p=0.029$). The mCIMT group exhibited significantly higher total scores on the Stroke Specific Quality of Life Scale (SS-QoL), as well as in the mobility, self-care, thinking, mood, family, and social roles subdomains, following the mCIMT intervention ($p<0.05$). The overall changes in strength and quality of life exhibited a stronger correlation with improvements during the mCIMT period compared to the baseline period.

The researcher conducted the Wilcoxon signed-rank test and the Mann-Whitney U test to assess static balance and balancing capacity on the unaffected leg during the single-limb stance test. Intragroup analysis the Wilcoxon signed-rank test indicated statistically significant effectiveness in the single-limb stance of the unaffected limb for both the experimental and control groups (Z experimental = -4.107, p = 0.000; Z control = -3.920, p = 0.000), thereby affirming the efficacy of both treatments over the 16 sessions. Outcomes The Mann–Whitney U test indicated a statistically significant difference between the two groups in the between-groups analysis. (U = 82.000, p = .001) indicates that in two groups, the mCIMT in the experimental group significantly enhanced static balance in the unaffected limb, demonstrating increasing relevance in improving static balance as assessed by the single-limb stance test in stroke patients. Utilizing the dynamical systems framework for motor control, García-Salazaret et al. (2022) investigate the impact of Lower Extremity Constraint-Induced Movement Therapy (LE-CIMT) on intra-limb hip-knee coordination and walking variability in

persons with chronic post-stroke conditions. Their investigation revealed more significant variations during the swing portion of the gait cycle.

The investigator assessed the patient's ambulation level employing the Wilcoxon signed-rank test and the Mann-Whitney U test according to the functional ambulation category. Intra-group analyses of functional ambulation categories utilizing the Wilcoxon signed-rank test revealed statistically significant improvements in for both groups (Experimental group: $Z = -4.187$, $p = 0.000$; Control group: $Z = -4.058$, $p = 0.000$), indicating that the 16 sessions were effective for both treatment approaches. However, intergroup analysis via the Mann-Whitney U test indicated that the disparity between the experimental group and the control group was not statistically significant ($U = 173.500$, $p = .172$), suggesting that the enhancement of the patient's ambulation level, with the incorporation of mCIMT, did not yield a statistically superior effect on ambulation as assessed by the functional ambulation category in stroke patients. Abdullahi et al. (2021) demonstrated that the primary outcome (motor function) and the other study outcomes (balance, functional mobility, knee extensor spasticity, walking speed, endurance, and exertion) improved significantly ($p < 0.05$) in both groups 1 and 2 before and after the initiation of activities from baseline to 2 weeks and 4 weeks after the intervention. During the stance phase, significant effects were observed for knee range of motion, hip range of motion, knee peak angles, hip peak angles, and trunk peak angles. During the swing phase, significant effects were observed for the range of motion at all joints, particularly at the knee peak. Both knee and hip range of motion exhibited greater values during the swinging of the non-paretic limb.

Utilizing the dynamical systems framework for motor control, García-Salazaret et al. (2022) investigate the impact of Lower Extremity Constraint-Induced Movement Therapy (LE-CIMT) on intra-limb hip-knee coordination and walking variability in persons with chronic post-stroke conditions. Their investigation revealed more significant variations during the swing portion of the gait cycle. e Silva et al. (2017) discovered that postural balance and functional flexibility in stroke patients were enhanced following two weeks of treadmill gait training (focusing on the non-affected lower limb) and home exercises. The study indicates that additional load on CIMT did not enhance training outcomes. Aloraini (2022) identified a significant difference

between the groups, with the CIMT program demonstrating greater improvement than the control group program. The analysis of between-subjects effects revealed that the CIMT group exhibited significantly higher scores than the control group. ANOVA results indicated that BBS scores significantly increased as the therapeutic program advanced. ANOVA results indicated that BBS scores significantly increased as the therapeutic program advanced.

Menezes-Oliveira et al. (2024) discovered in their research that LE-CIMT outperformed on the Assistance and Confidence subscale of the Lower Extremity – Motor Activity Log, Mini-BESTest, and 6-Minute Walk Test. The effect size for all outcomes was minimal when comparing the two groups. LE-CIMT demonstrated clinically significant variations in daily activities, balance, and gait ability, while exhibiting no clinically significant differences in spatiotemporal characteristics. The trial results indicate that the gait analysis conducted on the patients showed significant favorable effects on gait following a stroke in individuals who underwent modified constraint-induced movement therapy (mCIMT). Functional assessments, including TUG, ten-meter walk, and single-leg stance, showed enhancement post-treatment, especially within the mCIMT group. Both the experimental and control groups exhibited improvement over time; however, a greater number of individuals in the experimental group demonstrated enhancement compared to the control group. However, not all assessments demonstrated a significant disparity between the two groups; in the functional ambulation category, this suggests that while mCIMT is broadly helpful, its efficacy may vary among functional domains. This study underscores the beneficial effects of mCIMT in stroke patients exhibiting gait dysfunction. Umar and Abdullahi (2020) questioned whether the lower limb LE-CIMT enhanced gait and balance outcomes post-stroke.

5.2 Limitations of the study:

This study presents some limitations. The study's sample size was limited compared to the overall population of the two groups, potentially hindering the ability to generalize findings to all individuals experiencing gait disturbances resulting from stroke. Consequently, further research with improved quality and larger sample sizes is necessary to validate the impact of modified CIMT on lower limb function following a stroke. The researcher only examined the effect of modified CIMT after 16 sessions, so the long-term effects of treatment were not investigated in this study. Furthermore, the researcher did not have sufficient time for this study, and it was conducted only at CRP Savar. In the neurology and stroke rehabilitation units of CRP, not all physiotherapists possessed the same skill level, which could influence the results. Occasionally, CRP patients did not receive a schedule for their therapy, leading to irregular attendance. A few patients discontinued therapy for personal reasons and returned to CRP after a few days, which disrupted the continuity of therapy. Moreover, there were no existing studies in Bangladesh in this field of research, which means very little data are available on modified CIMT in Bangladesh. Therefore, more studies should be carried out to verify whether mCIMT is effective for stroke survivors with gait dysfunction.

Chapter-vi Conclusion and Recommendations

6.1 Conclusion

Modified CIMT is a feasible and valuable form of intervention in the treatment of LE mobility impairments in patients post-stroke. The present study indicates mCIMT is useful for patients with gait dysfunction in the stroke population. These results may contribute to clinical practice to facilitate the application of modified CIMT to enhance lower extremity function in stroke survivors. Due to the difficulties and potential hazards of using constraint devices, the use of shaping techniques is thus advocated in combination with behavioral strategies in order to obtain greater and longer-lasting progress.

6.2 Recommendation

The present study demonstrated the effectiveness of mCIMT in stroke patients exhibiting gait dysfunction. Additional studies are essential to identify the optimal mCIMT combination and to design more rigorous investigations that validate its efficacy. The study was conducted in the Savar CRP with a limited sample size. Future studies should incorporate a larger sample size and an expanded study region. In this study, the researcher had limited tools to assess the patients and encountered problems during the research, and this study is single-blinded. In future studies, it is advised to ensure that adequate tools are available during the research and to conduct double and triple-blinded studies. Furthermore, not all physiotherapists who participated in this research had the same level of skill. Therefore, it is recommended to address this aspect in future studies of this type. Moreover, the compensatory movements remain a challenge for stroke survivors to overcome; thus, mCIMT also further motivates patients to activate functional recovery by exercising these movements. Stroke recovery is a complex process and should be individualised to enhance functional performance and participation.

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Appendix-1

IRB approval letter

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

Ref: CRP-BHPI/IRB/12/2024/1013 Date: 15/12/2024

To
Rubyat Sharmin Ruma
4th year B.Sc. in Physiotherapy
Session: 2019-2020, Student ID: 112190484

Subject: Approval of the thesis proposal "Therapeutic efficacy of modified Constraint Induced Movement Therapy on patients with gait dysfunction in the stroke population: A randomized clinical trial" by the ethics committee.

Dear Rubyat Sharmin Ruma,
Congratulations!
The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the dissertation as mentioned above, with you, as the principal investigator and Asma Islam, Associate Professor, Department of Physiotherapy, BHPI as thesis supervisor. The following documents have been reviewed and approved:

Sl. no.	Name of the documents
1	Thesis Proposal
2	Questionnaire (English version)
3	Information sheet and consent form

The purpose of the study is to determine the efficacy of modified Constraint Induced Movement Therapy (mCIMT), which is applied to the lower extremity to improve gait in patients with gait dysfunction in stroke. The study involves the use of a Timed up and go test, 10-meter walk test, single leg stance test, and functional ambulation category that may take 20 to 30 minutes to participate in the test with instruction for the collection of specimens and there is no likelihood of any harm to the participants. The members of the Ethics Committee have approved the study to be conducted in the presented form at the meeting held at **9 AM on 15th July 2024 at BHPI (44th IRB Meeting).**

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

Best regards,

Muhammad Millat Hossain,
Associate Professor and Course Coordinator, MRS
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

Appendix-2

Data collection permission letter

Date: 26/12/2024

Head

Department of Physiotherapy

Centre for the Rehabilitation of the Paralysed (CRP)

Chapain, Savar, Dhaka-1343

Through: Head, Department of Physiotherapy, BHPI.

Subject: **Prayer for seeking permission to collect data for conducting a research project.**

Sir,

With due respect and humble submission to state that I am Rubyat Sharmin Ruma, a student in 4th year B.Sc. in physiotherapy at Bangladesh Health Professions Institute (BHPI). The Ethical committee has approved my research project entitled: **"Therapeutic efficacy of modified Constraint Induced Movement Therapy on patients with gait dysfunction in the stroke population: A randomized clinical trial"** under the supervision of Asma Islam, Associate Professor, Department of Physiotherapy, BHPI. I want to collect data for my research project from the Department of Physiotherapy at CRP. So, I need permission for data collection from the Neurology Unit and Stroke Rehabilitation Unit of the Physiotherapy Department at CRP-Savar, Dhaka-1343. I would like to assure you that anything in the study will not be harmful to the participants and the Department itself.

I, therefore pray and hope that you would be kind enough to grant my application and give me permission for data collection and oblige thereby.

Yours faithfully,

Rubyat Sharmin Ruma

Rubyat Sharmin Ruma

4th Year

B.Sc. in Physiotherapy

Class Roll: 06; Session: 2019-2020, ID: 112190484

Bangladesh Health Professions Institute (BHPI)

(An academic Institution of CRP)

CRP, Chapain, Savar, Dhaka- 1343.

Forewarded to HOD(PT, BHPI)
Asma Islam
28/12/2024

Forwarded
Sir,
29.12.2024.

Dr. Shazal Kumar Das, PhD
Assistant Professor and Head
Department of Physiotherapy
BHPI, CRP, Savar, Dhaka-1343.

Approved
31/12/24

Prof. Dr. Mohammad Ahwar Hossain, PhD
Professor Physiotherapy Department BHPI
Senior Consultant & Head
Physiotherapy Department
CRP, Savar, Dhaka-1343

Appendix-3

Consent Form (Bangla)

সম্মতি পত্র

আসসালামু আলাইকুম / নমস্কার,

আমি **রুবাইয়াত শারমিন রুমা**, বাংলাদেশ হেলথ প্রফেশনস ইনস্টিটিউট (বিএইচপিআই), সিআরপি- এর ফিজিওথেরাপি বিভাগ এর ৪র্থ বর্ষের ছাত্রী। আমি **"স্ট্রোক জনসংখ্যায় গেইট ডিসফাংশন সহ রোগীদের উপর মডিফাইড কন্সট্রেইন্ট ইনডিউসড মুভমেন্ট থেরাপি এর থেরাপিউটিক কার্যকারিতা: একটি র‍্যান্ডমাইজ ক্লিনিকাল ট্রায়াল"** শিরোনামের গবেষণা পরিচালনা করছি।

আমি স্ট্রোক সম্পর্কিত কিছু ব্যক্তিগত এবং অন্যান্য সম্পর্কিত তথ্য সম্পর্কে জানতে চাই। এটি প্রায় 20 মিনিট সময় নেবে। এটি একটি একাডেমিক অধ্যয়ন এবং অন্য কোন উদ্দেশ্যে ব্যবহার করা হবে না। গবেষক সরাসরি নিউরোলজি ইউনিট এবং স্ট্রোক পুনর্বাসন ইউনিটের সাথে সম্পর্কিত নন, তাই গবেষণায় আপনার অংশগ্রহণ নিউরোলজি ইউনিটে বা স্ট্রোক পুনর্বাসন ইউনিটে আপনার বর্তমান বা ভবিষ্যতের চিকিৎসার উপর কোন প্রভাব ফেলবে না। গবেষক সকল পদ্ধতির গোপনীয়তা বজায় রাখবেন। আপনার অনুমতি ছাড়া আপনার তথ্য ব্যবহার করা হবে না । এই গবেষণায় আপনার অংশগ্রহণ স্বেচ্ছাসেবী এবং আপনি এই অধ্যয়নের সময় যেকোনো সময় নিজেকে প্রত্যাহার করতে পারেন।

ধরুন আপনার অধ্যয়ন বা অংশগ্রহণকারী হিসাবে আপনার অধিকার সম্পর্কে কোন প্রশ্ন আছে। সেক্ষেত্রে আমার সাথে যোগাযোগ করতে পারেন অথবা আমার সুপারভাইজার আসমা ইসলাম, সহযোগী অধ্যাপক, ফিজিওথেরাপি বিভাগ, বিএইচপিআই, সিআরপি, সাভার, ঢাকা।

তাহলে, ইন্টারভিউ বা কাজের জন্য আমি কি আপনার সম্মতি পেতে পারি?

হ্যা _____ না_____

অংশগ্রহণকারীর স্বাক্ষর _____ তারিখ_____

ইন্টারভিউয়ারের স্বাক্ষর _____ তারিখ _____

প্রশ্নপত্র

শিরোনামঃ **"স্ট্রোক জনসংখ্যায় গেইট ডিসফাংশন সহ রোগীদের উপর মডিফাইড কন্সট্রেইন্ট ইনডিউসড মুভমেন্ট থেরাপি এর থেরাপিউটিক কার্যকারিতা: একটি র‍্যান্ডমাইজ ক্লিনিকাল ট্রায়াল"**

অংশঃ ১ রোগীর পরিচয়

রোগীর আইডি:

রোগীর নাম:

ঠিকানা:

মোবাইল নম্বর:

তথ্য সংগ্রহের স্থান:

সাক্ষাৎকারের তারিখ:

অংশঃ ২ সামাজিক-জনসংখ্যা সংক্রান্ত তথ্য

প্রশ্ন নম্বর	প্রশ্ন	উত্তর
২.১	বয়স	_____বছর
২.২	লিঙ্গ	১= পুরুষ ২= মহিলা
২.৩	বৈবাহিক অবস্থা	১= বিবাহিত ২= অবিবাহিত ৩= তালাকপ্রাপ্ত ৪= বিধবা
২.৪	বসবাসের স্থান	১= গ্রাম ২= মফস্বল ৩= শহর
২.৫	শিক্ষাগত অবস্থা	১= কোন প্রাতিষ্ঠানিক শিক্ষা নেই ২= প্রাথমিক শিক্ষা ৩= মাধ্যমিক শিক্ষা ৪= উচ্চ মাধ্যমিক শিক্ষা ৫= স্নাতক ডিগ্রী বা তার উপরে

২.৬	পেশা	১= গৃহিণী ২= গার্মেন্টস কর্মী ৩= ড্রাইভার ৪= দিন মজুর ৫= ব্যবসায়ী ৬=কৃষক ৭= দোকানদার ৮= অন্যান্য
২.৭	স্ট্রোকের ঘটনার সময়কাল	_____মাস
২.৮	স্ট্রোকের পারিবারিক ইতিহাস	১= হ্যা ২= না
২.৯	স্ট্রোকের ধরন	১= ইস্কেমিক ২= হেমোরেজিক ৩= অনির্দিষ্ট
২.১০	আক্রান্ত পাশ	১= ডান ২= বাম
২.১১	কো-মরবিডিটি	১= উচ্চ রক্তচাপ ২= ডায়াবেটিস মেলিটাস ৩= হৃদরোগ ৪= ফুসফুসের রোগ ৫= অন্যান্য

অংশঃ ৩ টাইম আপ অ্যান্ড গো টেস্ট এর মাধ্যমে কার্যকরী গতিশীলতা মূল্যায়ন

সরঞ্জামঃ স্টপওয়াচ

সাধারণ নির্দেশনাঃ

১। রোগী যথারীতি তাদের জুতা পরবে এবং প্রয়োজনে সহায়ক ডিভাইস ব্যবহার করতে পারবে।

২। রোগী বসে থাকা অবস্থায় শুরু হবে।

৩। রোগীকে নির্দেশ দেওয়াঃ

যখন আমি বলব "যাও," আমি আপনার থেকে চাইব যে

- চেয়ার থেকে উঠে দাঁড়ান

- ৩ মিটার এগিয়ে যান
- ঘুরে যান
- চেয়ারে ফিরে আসুন এবং
- পুনরায় বসুন।

৪। "যাও," শব্দটির থেকে সময় গণনা শুরু হবে।

৫। রোগী বসার পরেই সময় গণনা বন্ধ করতে হবে।

৬। সময় রেকর্ড করতে হবে।

৭। সহায়ক ডিভাইস ব্যবহার করা হলে অবশ্যই ডকুমেন্ট করতে হবে।

সহায়ক ডিভাইসঃ _____

- কোনটিই নয়
- লাঠি
- ওয়াকার
- ক্রাচ
- অন্যান্য

টাইম আপ অ্যান্ড গো টেস্ট (সেকেন্ড)	**পূর্ববর্তী পরীক্ষা**	**পরবর্তী পরীক্ষা**
১ম সময় পরিমাপ		
২য় সময় পরিমাপ		
গড় পরিমাপ		

অংশঃ ৪ সিংগেল লেগ স্ট্যানস টেস্ট এর মাধ্যমে এক পায়ে দাঁড়ানোর এবং ভারসাম্য বজায় রাখার ক্ষমতা মূল্যায়ন

সরঞ্জামঃ স্টপওয়াচ

সাধারণ নির্দেশনাঃ

১। রোগী নিতম্বের উপর হাত রেখে শান্ত দাঁড়িয়ে থাকা অবস্থায় শুরু করে।

২। রোগী মাটি থেকে এক পা তুলে নেয় এবং সাহায্য না নিয়ে দাঁড়িয়ে থাকে।

৩। পা মাটি থেকে উঠলে সময় গণনা শুরু হবে।

৪। সময় থেমে যায় যখন উত্তোলিত পা মাটির সাথে যোগাযোগ করে, স্ট্যান্স লিম্বের সাথে যোগাযোগ করে, যখন স্ট্যান্স পা মেঝেতে পাশের দিকে চলে যায়, বা যখন হাত নিতম্ব ছেড়ে যায়।

৫। সময় রেকর্ড করতে হবে।

পূর্ববর্তী পরীক্ষা

সিংগেল লেগ স্ট্যানস টেস্ট	**আক্রান্ত পা (সেকেন্ড)**	**সুস্থ পা (সেকেন্ড)**
১ম সময় পরিমাপ		
২য় সময় পরিমাপ		
গড় পরিমাপ		

পরবর্তী পরীক্ষা

সিংগেল লেগ স্ট্যানস টেস্ট	**আক্রান্ত পা (সেকেন্ড)**	**সুস্থ পা (সেকেন্ড)**
১ম সময় পরিমাপ		
২য় সময় পরিমাপ		
গড় পরিমাপ		

অংশঃ ৫ দশ মিটার ওয়াক টেস্ট এর মাধ্যমে হাঁটার গতি মূল্যায়ন

সরঞ্জামঃ স্টপওয়াচ

সাধারণ নির্দেশনাঃ

১। একজন ব্যক্তি সহায়তা ছাড়াই ১০ মিটার (৩২.৮ফুট) হাঁটেন। ত্বরণ এবং হ্রাসের জন্য ৬ মিটার (১৯.৭ ফুট) মধ্যবর্তী দূরত্বের জন্য সময় রেকর্ড করা হয়।

২। যখন অগ্রণী পায়ের আঙ্গুল ২-মিটার চিহ্ন অতিক্রম করে তখন সময় শুরু হবে।

৩। যখন অগ্রণী পায়ের আঙ্গুলগুলি ৮-মিটার চিহ্ন অতিক্রম করে তখন সময় গণনা বন্ধ করতে হবে।

৪। সহায়ক ডিভাইস ব্যবহার করা হলে অবশ্যই ডকুমেন্ট করতে হবে।

সহায়ক ডিভাইসঃ _____

- কোনটিই নয়
- লাঠি
- ওয়াকার
- ক্রাচ
- অন্যান্য

পূর্ববর্তী পরীক্ষা

১০ মিটার ওয়াক টেস্ট (সেকেন্ড)	**আরামদায়ক হাঁটার গতির জন্য সময়**	**আরামদায়ক হাঁটার গতির জন্য গড় সময়**	**হাঁটার গতি (মি/সে)**
১ম সময় পরিমাপ			
২য় সময় পরিমাপ			

পরবর্তী পরীক্ষা

১০ মিটার ওয়াক টেস্ট (সেকেন্ড)	**আরামদায়ক হাঁটার গতির জন্য সময়**	**আরামদায়ক হাঁটার গতির জন্য গড় সময়**	**হাঁটার গতি মি/সে**
১ম সময় পরিমাপ			

২য় সময় পরিমাপ			

অংশঃ ৬ ফাংশনাল অ্যাম্বুলেশন ক্যাটাগরি দ্বারা অ্যাম্বুলেশন ক্ষমতা মূল্যায়ন:

স্কোর	ক্যাটাগরি	ব্যাখ্যা
০	নন ফাংশনাল অ্যাম্বুলেটর	রোগী হাঁটতে পারে না।
১	অ্যাম্বুলেটর, শারীরিক সহায়তার উপর নির্ভরশীল - স্তর ১	রোগীর একজন ব্যক্তির কাছ থেকে দৃঢ় অবিরাম সমর্থন প্রয়োজন যিনি ওজন বহন করার পাশাপাশি ভারসাম্য বজায় রাখতে সহায়তা করেন।
২	অ্যাম্বুলেটর, শারীরিক সহায়তার উপর নির্ভরশীল - স্তর ২	ভারসাম্য এবং সমন্বয়ের জন্য রোগীর একজন ব্যক্তির কাছ থেকে ক্রমাগত বা বিরতিহীন সহায়তা প্রয়োজন।
৩	অ্যাম্বুলেটর, তত্ত্বাবধানের উপর নির্ভরশীল	রোগীর শারীরিক যোগাযোগ ছাড়াই একজন ব্যক্তির কাছ থেকে মৌখিক তত্ত্বাবধান বা স্ট্যান্ড-বাই সাহায্য প্রয়োজন।
৪	অ্যাম্বুলেটর, স্বাধীন শুধুমাত্র সমতল পৃষ্ঠে	রোগী সমতল পৃষ্ঠে স্বাধীনভাবে হাঁটতে পারে, তবে সিঁড়ি, ঢাল বা অসম পৃষ্ঠে সাহায্যের প্রয়োজন হয়।
৫	অ্যাম্বুলেটর, স্বাধীন	রোগী সিঁড়ি সহ যেকোনো জায়গায় স্বাধীনভাবে হাঁটতে পারে।

ফাংশনাল অ্যাম্বুলেশন ক্যাটাগরি	স্কোর
পূর্ববর্তী পরীক্ষা	
পরবর্তী পরীক্ষা	

Appendix-4

Consent form

(Please read out to the participants)

Assalamualaikum/Adab,

I am **Rubyat Sharmin Ruma**, a 4th-year B.Sc. in Physiotherapy student at Bangladesh Health Professions Institute (BHPI). I am conducting research entitled "**Therapeutic efficacy of modified Constraint Induced Movement Therapy on patients with gait dysfunction in the stroke population: A randomized clinical trial**."

I would like to know some personal and other related information regarding stroke. This will take approximately 20 minutes. This is an academic study and will not be used for any other purpose. The researcher is not directly related to the neurology unit and Stroke Rehabilitation Unit, so your participation in the research will have no impact on your present or future treatment in the neurology unit. The researcher will maintain the confidentiality of all procedures. Your data will never be used without your permission. Your participation in this study is voluntary and you may withdraw yourself at any time during this study.

Suppose you have any queries about the study or your rights as a participant. In that case, you may contact me or my supervisor, Asma Islam, Associate Professor, Department of Physiotherapy, BHPI, CRP, Savar, Dhaka.

So, may I have your consent to proceed with the interview or work?

Yes…… No……

Signature of the participant _____ Date _____

Signature of the Interviewer _____ Date _____

Questionnaire

Title: "Therapeutic efficacy of modified Constraint Induced Movement Therapy on patients with gait dysfunction in the stroke population: A randomized clinical trial."

SECTION 1: Patient's identification

Patient ID:

Patient's name:

Address:

Contact number:

Place of data collection:

Date of interview:

SECTION 2: Socio-demographic information

Q. N	Question	Response
2.1	Age	…… years
2.2	Gender	1= Male 2= Female
2.3	Marital status	1= Married 2= Unmarried 3= Divorced 4= Widow
2.4	Living area	1= Rural 2= Semi-urban 3= Urban
2.5	Educational status	1= No formal education 2= Primary education 3= Secondary education 4= Higher secondary education

		5= Bachelor's degree or above
2.6	Occupation	1= Housewife 2= Garments worker 3= Driver 4= Day labor 5= Businessman 6= Farmer 7= Shop keeper 8= Others
2.7	Duration of the incidence of stroke	…….. months
2.8	Family history of stroke	1= Yes 2= No
2.9	Stroke type	1= Ischemic 2= Hemorrhagic 3= Undefined
2.10	Affected side	1= Right 2= Left
2.11	Comorbidity	1= Hypertension 2= Diabetes mellitus 3= Heart disease 4= Lung disease 5= Other

SECTION 3: The tone is measured by the Modified Ashworth Grading Scale

Instruction: The measured joint is positioned in a standardized, neutral position (The patient is supine on an examination bed). The therapist moves the joint through the full range of maximal possible flexion to maximal possible extension for 'about one second'. The therapist rates the resistance to passive muscle movement on the scale below-

Grade	Description	Score
0	No increase in tone	
1	Slight increase in muscle tone, manifested by a catch and release or minimal resistance at the end of the ROM when the affected part(s) is moved in flexion or extension	
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM	
2	A more marked increase in muscle tone through most of the ROM, but the affected part(s) easily moved	
3	Considerable increase in muscle tone, passive movement is difficult	
4	Affected part(s) are rigid in flexion or extension	

SECTION 4: Balance is measured by the Berg Balance Scale

SL. NO.	Question (score: 0-4)	Score
1	Sitting to standing	
2	Standing unsupported	
3	Sitting with back unsupported but feet supported on the floor or a stool	
4	Standing to sitting	
5	Transfers	
6	Standing unsupported with eyes closed	
7	Standing unsupported with feet together	
8	Reaching forward with an outstretched arm while standing	

9	Pick up an object from the floor from a standing position	
10	Turning to look behind over the left and right shoulders while standing	
11	Turn 360 degrees	
12	Place alternate foot on the step or tool while standing unsupported	
13	Standing unsupported on one foot in front	
14	Standing on one leg	

Pre-assessment (Baseline)

SECTION 5: Assess functional mobility by the Timed Up and go test

Equipment: Stopwatch

General instruction:

1. Patient wear their regular footwear and can use a walking aid if needed.
2. The patient starts in a seated position.
3. Instruct the patient:

   When I say "Go," I want you to:

   - Stand up from the chair
   - Walks forward 3 meters
   - Turns around
   - Return to the chair
   - Sit down again
4. On the word "Go," begin timing.
5. Stop timing after the patient sits back down.
6. Record time.
7. Be sure to document if the assistive device is used.

Assistive Device and/or Bracing Used: _____

- None

- Cane
- Walker
- Crutch
- Others

Timed up and go test	Second (s)
1st-time measurement	
2nd-time measurement	
Average measurement	

Section 6: Measure the ability to stand on one leg and maintain balance by the single-leg stance test

Equipment: Stopwatch

General instruction:

1. The patient begins in a quiet standing position with hands on the hips.
2. The patient lifts one leg off the ground and stands unassisted.
3. Time starts when the foot is lifted off the ground.
4. Time stops when the lifted foot either makes contact with the ground, makes contact with the stance limb, when the stance foot moves laterally on the floor, or when the hands leave the hips.
5. Record time.

Pre-test:

Single limb stance tast	Affected leg (second)	Unaffected leg (second)
1st-time measurement		

2nd-time measurement		
Average measurement		

Section 7: Walking speed is measured by the Ten Meter Walk Test

Equipment: Stopwatch

General information:

1. An individual walks without assistance 10 meters (32.8 feet). Time is recorded for the intermediate distance of 6 meters (19.7 feet) to account for acceleration and deceleration.
2. Start timing when the toes of the leading foot cross the 2-meter mark
3. Stop timing when the toes of the leading foot cross the 8-meter mark
4. Be sure to document if the assistive device is used.

Assistive Device and/or Bracing Used: _____

- None
- Cane
- Walker
- Crutch
- Others

Pre-test:

10-meter walk test	**Time for a comfortable walking speed**	**Average time for a comfortable walking speed**	**Gait speed (m/s)**
1st-time walk measurement			

2nd-time walk measurement			

Section 8: Evaluate ambulation ability by Functional Ambulation Category

Score	Category	Interpretation
0	Nonfunctional ambulator	The patient cannot walk
1	Ambulator, dependent on physical assistance – level I	The patient needs firm, continuous support from one person who helps carry weight as well as maintain balance.
2	Ambulator, dependent on physical assistance – level II	The patient needs continuous or intermittent support from one person to help with balance and coordination.
3	Ambulator, dependent on supervision	The patient requires verbal supervision or stand-by help from one person without physical contact
4	Ambulator, independent level surface only	The patient can walk independently on a level surface but requires help on stairs, slopes, or uneven surfaces.
5	Ambulator, independent	The patient can walk independently anywhere, including stairs.

Functional ambulation category	Score

Pre-test	

Post-assessment (after 16 sessions)

SECTION 9: Assess functional mobility by the Timed Up and Go test

Equipment: Stopwatch

Assistive Device and/or Bracing Used: _____

- None
- Cane
- Walker
- Crutch
- Others

Timed up and go test (second)	**Post-test**
1st-time measurement	
2nd-time measurement	
Average measurement	

Section 10: Measure the ability to stand on one leg and maintain balance by the single-leg stance test

Equipment: Stopwatch

Post-test:

Single limb stance task	**Affected leg (second)**	**Unaffected leg (second)**

1st-time measurement		
2nd-time measurement		
Average measurement		

Section 11: Walking speed is measured by the Ten Meter Walk Test

Equipment: Stopwatch

Assistive Device and/or Bracing Used: _____

- None
- Cane
- Walker
- Crutch
- Others

Post-test:

10-meter walk test	**Time for a comfortable walking speed**	**Average time for a comfortable walking speed**	**Gait speed (m/s)**
1st-time walk measurement			
2nd-time walk measurement			

Section 12: Evaluate ambulation ability by Functional Ambulation Category

Score	Category	Interpretation
0	Nonfunctional ambulator	The patient cannot walk
1	Ambulator, dependent on physical assistance – level I	The patient needs firm, continuous support from one person who helps carry weight as well as maintain balance.
2	Ambulator, dependent on physical assistance – level II	The patient needs continuous or intermittent support from one person to help with balance and coordination.
3	Ambulator, dependent on supervision	The patient requires verbal supervision or stand-by help from one person without physical contact
4	Ambulator, independent level surface only	The patient can walk independently on a level surface but requires help on stairs, slopes, or uneven surfaces.
5	Ambulator, independent	The patient can walk independently anywhere, including stairs.

Functional ambulation category	Score
Post-test	

Appendix-5

Treatment protocol for the control group

Conventional physiotherapy treatment for gait in patients with stroke.

Intervention:

Treatment protocol for the control group:

1. Therapeutic positioning:

- Posture correction
- Skilled facilitation includes: lateral pelvic shift
- Active lying
- Active sitting
- Active Standing

2. Range of motion/ flexibility training

- Selective movement of the whole body
- Guided movement
- Dissociative movement

3. Stretching

- Stretching exercise
- Ankle-foot strategic exercise in lying

4. Sensory motor activity

- Sensory stimulation
- Neuromuscular reeducation
- The sensory-motor performance
- Proprioception training

5. Strength training

- Isometric training
- Trunk control exercise

- Pelvic tilting exercise
- Abductor and adductor muscle strengthening exercise
- Core strengthening exercise
- Half squatting practice
- Full squatting practice
- Lunge exercise practice
- Active facilitatory exercise in lying
- Bridging exercise followed by modified bridging

6. Mobility training

- Foot preparation
- Calf muscle activation
- Abdominal muscle activation
- Gluteal muscle activation
- Facilitation of hip flexion

7. Balance and coordination training:

- Postural control
- Trunk and pelvic stabilization exercise
- Weight-bearing exercise in standing
- Static and dynamic balance training
- Dynamic standing balance practice
- Weight-bearing exercise
- Weight-shifting exercise
- Controlled weight shifting
- Balance training (heel-to-toe, balance board)

8. Gait training:

- Stepping practice
- Target stepping
- Side-stepping practice

- Backward walking
- Gait training on the parallel bars
- Stairing practice

Signature:

Debanand Bodmangi 24/04/25

Amina Akter 24.04.25

24.04.25

Hamida 24.04.25

Fabiha 24.04.25

24.04.25

24.04.25

29.4.25

29.04.25

Saleha Fazal 24.04.25

Zarrin Tasnim 24.04.25