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Efficacy of cognitive dual-task training on balance in patients with stroke

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We the undersigned certify that we have carefully read and recommended to the Faculty of Medicine, University of Dhaka, for the acceptance of this dissertation entitled, **"Efficacy of cognitive dual-task training on balance in patients with stroke"** Submitted by **Sabrina Tina,** for the partial fulfillment of the requirement for the degree of Bachelor of Science in Physiotherapy (BSc. PT).

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Declaration

I solemnly declare that the present dissertation entitled **"Efficacy of cognitive dual-task training on balance in patients with stroke"** embodies the original work carried out solely by me and has been prepared in partial fulfillment of the requirements for the academic degree. All sources used have been cited appropriately and acknowledged. Any mistakes or inaccuracies are my own. The ethical approval was duly obtained, and informed consent was secured from all participants prior to their involvement in the study. I also declare that for any publication, presentation, or dissemination of information from the study, I will be bound to obtain written consent from the supervisor and the Department of Physiotherapy of the Bangladesh Health Professions Institute (BHPI).

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Contents

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Abbreviations

ADL	Activity of Daily Livings
BBS	Berg Balance Scale
BHPI	Bangladesh Health Professions Institute
BMI	Body Mass Index
CDTT	Cognitive Dual-Task Training
CMDT	Cognitive-Motor Dual-Task Training
CRP	Centre for the Rehabilitation of the paralyzed
DT	Dual Task Training
IRB	Institutional Review Board
MDTT	Motor Dual-Task Training
MRP	Motor Relearning Program
RCT	Randomized Controlled Trial
TUG	Timed Up and G0
WHO	World Health Organization

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Abstract

Background: Stroke is a major cause of long-term disability and the second leading cause of death worldwide. Among stroke patients, balance and mobility impairments are evident due to both motor and cognitive dysfunctions. Cognitive Dual-Task training (CDTT) integrates cognitive challenges with motor activities, which is known to be effective in improving balance and gait, as evidenced by several scientific studies that have established its benefits. This study was therefore aimed to evaluate the efficacy of cognitive dual-task training on balance in patients with stroke. **Methodology:** A double-blinded randomized controlled trial was conducted with 40 participants randomly allocated and divided into control group (n=20), each receiving conventional physiotherapy, and experimental group (n=20), each receiving cognitive dual task training along with conventional physiotherapy for 3 days a week for 4 weeks. The primary outcome was balance (BBS), and the secondary outcomes included mobility and gait (TUG and Gait parameters). An intention-to-treat analysis using the LOCF method was employed. Data were analyzed using SPSS 25.0, employing both parametric and non-parametric tests. **Result:** Both groups demonstrated significant improvements in balance and mobility following the intervention. However, the experimental group showed significantly greater gains. Median BBS scores increased from 41.0 to 48.0 ($p = 0.000$) in the experimental group and from 44.0 to 47.0 in the control group ($p = 0.000$), with between-group differences favoring the experimental group ($p < 0.05$). TUG times improved significantly in both groups (experimental: 32.74 s to 28.01 s; control: 39.12 s to 37.03 s), with a greater improvement in the experimental group ($p = 0.043$). Gait parameters (step length, stride length, gait speed, cadence) also showed significantly greater improvements in the experimental group ($p < 0.05$ for all). **Conclusion:** CDTT was more effective than conventional therapy alone in enhancing balance, mobility, and gait in patients with stroke. Incorporating cognitive tasks into balance training may provide superior functional outcomes and should be considered in stroke rehabilitation programs.

Keywords: *Stroke, Balance, Cognitive Dual-task training, CDTT, Dual-Task training, Gait.*

Chapter-I	Introduction

1.1 Background

Stroke is a leading cause of mortality in the world (after cardiovascular diseases), and the rates of incidence in stroke are rising with the rise in age of the population; thus, it is a major risk factor to global health (Sharrief & Grotta, 2019; Kim et al., 2024). It is a neurological condition caused by injuries (e.g., infarction, hemorrhage) that affect the blood supply and tissue in the central nervous system. A stroke occurs when there is an interruption in the brain's blood supply due to vessel occlusion or haemorrhage. There are two primary forms of stroke: ischaemic stroke and haemorrhagic stroke. The blocked blood flow in brain vessels responsible for ischaemic stroke accounts for 85% of all stroke cases. Significant risk factors for ischaemic stroke include large-vessel atherosclerosis, cardio-embolism, and small-vessel occlusion. Any breakage and subsequent intracranial hemorrhage of a cerebral blood vessel constitutes about 15% of all strokes, referred to as a haemorrhagic stroke. Common factors contributing to the occurrence of haemorrhagic stroke include hypertension and aneurysms, alongside ruptured blood vessels (Murphy et al., 2020; Gomes & Wachsman, 2013).

Stroke-related death and disability rates remain extremely high throughout developing nations. Developing nations suffer from 75 percent of all deaths caused by strokes while bearing 81 percent of disability-related strokes worldwide (Feigin et al., 2016). Both infectious and non-infectious health conditions endanger the substantial populations of Bangladesh. Bangladesh identifies stroke as the third leading cause of death after cardiovascular issues and contagious diseases, including the flu and pneumonia. The World Health Organization reports that 134,166 stroke-related deaths occurred in Bangladesh during 2020, which represented 18.74% of the total mortality. Bangladesh ranks 41st worldwide, with an age-adjusted mortality rate of 119.20 per 100,000 population. According to the World Health Organization, it is estimated that 15 million individuals across the globe are affected by a stroke every year (Lindsay et al., 2019). Five million die, and five more come out permanently disabled (Vinychuk et al., 2020; Vinychuk & Fartushna, 2018; Fartushna & Vinychuk, 2017).

Sadat, Podder, and Biswas (2023) stated that the incidence and prevalence of stroke are rapidly increasing in Bangladesh due to inadequate health care management and a lack of public awareness. In total, the number of patients with stroke per 1000 participants was 1.04 (95% CI: 0.981.1). It occurs more in males than females at a ratio of about 1.58 to one. It becomes more prevalent as people age, particularly in the older population above the age of 80 (Rahman et al., 2022).

Many of the risk factors influencing the global incidence of stroke, including hypertension, diabetes, and lifestyle factors, are also prevalent in Bangladesh. The most common non-communicable diseases among stroke patients were hypertension (67.55%) and diabetes (25.21%). Stroke is caused by various risk factors, which are divided into modifiable and non-modifiable categories. Modifiable risk factors such as hypertension, diabetes, smoking, and obesity significantly increase the risk of stroke (Shamshiev et al., 2024; Moini et al., 2023). Conversely, non-modifiable risk factors, including age and genetic predisposition, substantially determine stroke vulnerability (Fitts, 2022). Symptoms typically present as sudden numbness, confusion, difficulty speaking, and severe headaches (Moini et al., 2023; Fitts, 2022). The impact of stroke on patients depends on the subtype as well as the region affected and the severity level (Gomes & Wachsman, 2013).

Stroke survivors develop cognitive deficits at rates exceeding 70% based on stroke classification combined with diagnostic criteria and assessment timing, which leads to disability, dependency, and morbidity (Pendlebury & Rothwell, 2019; Sexton et al., 2019). Stroke survivors exhibit increased variability in joint motion in both paretic and nonparetic limbs when walking, particularly in the sagittal plane, which contributes to balance and gait dysfunction (Cho et al., 2024). People with impaired balance encounter difficulty performing their day-to-day activities, which impacts both their overall well-being and their functional abilities. Multiple rehabilitation methods that combine traditional exercises with technology-based interventions and dual-task training demonstrate effectiveness in improving balance in survivors who had a stroke (Saraiva et al., 2023). Dual-task training involves performing a cognitive task (e.g., counting) while simultaneously performing a motor task (e.g., walking), thereby eliciting the brain's capacity to handle multiple demands simultaneously (Pal et al., 2024; Ferrais et al., 2024).

Cognitive dual-task training (CDTT) involves training a cognitive task simultaneously with a physical task to improve balance and mobility in stroke patients. Specifically, cognitive dual-task training is used to improve balance by targeting the ability to control competing cognitive and motor tasks (Sukala, 2021). The balance deficits of stroke patients become more pronounced during dual-task situations, emphasizing the need to incorporate cognitive challenges into rehabilitation programs (Abdollahi, Kuber, & Rashedi, 2024; Zhang et al., 2022). Stroke patients experience improved postural balance and a reduced risk of falls when they conduct proprioceptive exercises in conjunction with cognitive dual-task training (Chiaramonte et al., 2022). Effective dual-task training can significantly improve balance and gait, reducing the risk of falls and enhancing the overall quality of life for stroke survivors (Rai & Ganvir, 2019; Park & Lee, 2019). Dual-task training significantly enhances gait speed, cadence, stride length, and overall mobility in stroke survivors (Vecchio et al., 2024; Raghunadh, Swathi & Kumar, 2022). While CDTT shows promise, the superiority of dual-task training for balance improvement requires further investigation, particularly in diverse stroke populations (Zhang et al., 2022). Cognitive dual-task training can lead to the development of more comprehensive rehabilitation protocols that address both motor and cognitive deficits in stroke patients (Chiaramonte et al., 2022; Liu et al., 2017).

1.2 Rationale

Stroke is a leading cause of disability, with balance impairments affecting a significant portion of survivors. These impairments can significantly affect a patient's ability to perform daily activities and increase the risk of falls. Daily activities often require performing cognitive tasks while maintaining balance (e.g., walking and talking, or cooking). Cognitive exercises target the brain's ability to process information, make decisions, and control movements, while balance exercises focus on enhancing muscle strength, coordination, and stability, as well as reducing the risk of falls. Combining these two types of exercises may lead to synergistic effects, potentially improving balance function in stroke patients.

Conventional rehabilitation approaches primarily focus on motor tasks without incorporating cognitive challenges, which may not fully address the cognitive aspects that contribute to balance deficits. Several studies suggest that cognitive dual-task training or balance training combined with cognitive tasks is efficacious in improving balance and gait in stroke patients. Meta-analyses highlight the need for further investigation on the superiority of cognitive dual-task training for balance improvement compared to traditional balance training. Positive results could lead to broader adoption of cognitive dual-task training, potentially improving patient outcomes and greater independence in daily living.

To the best of my knowledge, no prior research has been done in Bangladesh on this subject. However, the specific effects on stroke patients at CRP remain unclear. This research proposal aims to investigate the effectiveness of cognitive dual-task training within this particular population.

1.3 Hypothesis

- **Null Hypothesis (Ho):** There is no significant difference in balance improvement between stroke patients who undergo cognitive dual-task training and those who receive conventional balance training at CRP.

$$Ho: \mu 1 - \mu 2 = 0$$

- **Alternative Hypothesis (Ha):** Stroke patients who undergo cognitive dual-task training at CRP will demonstrate greater improvements in balance compared to those who receive conventional balance training.

$$Ha: \mu 1 - \mu 2 \neq 0$$

1.4 Objectives of the study

1.4.1 General objective:

To evaluate the efficacy of cognitive dual-task training on balance in patients with stroke.

1.4.2 Specific objectives:

- To explore socio-demographic (age, sex, educational status, employment) characteristics of stroke patients.
- To determine the baseline compatibility of the participants
- To assess the impact of cognitive dual-task training on enhancing balance control.
- To compare the balance outcomes of cognitive dual-task training with those of conventional balance training methods in stroke patients.
- To assess the impact of cognitive dual-task training on fall risk reduction in stroke patients.
- To assess changes in gait parameters such as velocity, stride length, and cadence.

1.5 Operational definition

Stroke

According to the World Health Organization (WHO),

Stroke may be defined as 'rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than of vascular origin'.

Ischaemic stroke

Ischemic stroke is a type of cerebrovascular accident (CVA) caused by an obstruction in a cerebral blood vessel, leading to decreased blood flow and oxygen to the brain.

Haemorrhagic stroke

A type of stroke caused by the rupture of a cerebral blood vessel, leading to intracranial bleeding and neurological impairments.

Cognition

The mental processes involved in learning and understanding through experience, mental ability, and the senses.

Balance

The ability to maintain the body's center of mass within its base of support during both static and dynamic activities.

Gait

Gait refers to the coordinated movement pattern of the lower limbs during walking, which involves step initiation, stride length, cadence, and overall locomotion.

Conventional balance training

Conventional balance training focuses on physical exercises, such as standing on one leg or using balance boards, without integrating cognitive challenges.

Dual task training

A rehabilitation intervention that involves performing a motor task simultaneously with a cognitive or secondary motor task to improve functional outcomes. In this study, dual-task training involves structured exercises that combine a balance or gait task with a cognitive challenge (e.g., counting backward, word recall) to evaluate its effect on balance in stroke patients.

Cognitive dual-task training

Cognitive Dual-Task Training (CDTT) is a rehabilitation approach that involves performing a motor task (such as walking or balancing) simultaneously with a cognitive task (such as counting, recalling memories, or solving problems). This type of training aims to improve functional mobility and cognitive processing by challenging the brain's ability to divide attention between tasks.

Chapter-II	Literature Review

A stroke occurs as an abrupt, localized impairment of the nervous system caused by brain dysfunction (Gomez-Cuaresma et al., 2021). The World Health Organization (WHO) defines stroke as "rapidly developing indications of focal impairment of brain function, lasting more than 24 hours or resulting in death, with no clear cause other than that of vascular origin." The posterior cerebral circulation is involved in 20% of strokes, while vertigo affects over 60% of patients. Stroke is the most common condition that limits mobility and daily life abilities (Rai & Ganvir, 2020; Kirthika et al., 2023).

Stroke is a diverse condition characterized by an abrupt, localized disruption of cerebral blood flow, resulting in neurologic impairments. Strokes can occur in various areas of the blood supply and typically involve anomalies of the brain arteries. Every year, 102 million individuals worldwide suffer a stroke. The incidence of ischaemic strokes rises with age (Moini et al., 2023). The prevalence of stroke in Bangladesh's population follows these stepped patterns: 20% in the age group 40-49 and 30% in the age group 50-59, while the incidence of stroke shows zero for those 60-69 and only 1% for people aged 80 and older and 70-79 years. The ratio of male to female patients found in this research was 3.14 males to 2.41 females (Sadat, Podder, & Biswas, 2023).

Patients who suffer strokes experience long-lasting and substantial effects, with diminished brain function having the most significant impact (Stroke Association, 2017). In certain high-income nations, up to one in five persons will experience a stroke in their lifetime; in low-income countries, the number can reach nearly one in two. It is the second leading cause of death globally. Cardioembolism, major artery disease, and small vessel disease are among the vascular aetiologies that are the most common causes of ischaemic stroke. Intracerebral haemorrhage is most frequently caused by small vessel disease, which is followed by macrovascular disease. Multimodal CT or MRI can show the site of arterial occlusion, the ischaemic penumbra, and the infarct core in cases of acute ischaemic stroke. Neuroimaging detects early radiological signs of haemorrhage expansion and the likely underlying aetiology of intracerebral bleeding (Hilkens et al., 2024).

Reduced blood flow brought on by artery narrowing or total blood flow obstruction from an embolism results in brain infarction. However, haemorrhage results from an artery or aneurysm rupturing, which causes blood to pool in the brain parenchyma (Khan et al., 2020). Approximately 84% of strokes are ischaemic strokes, which are brought on by embolism or thrombosis and result in inadequate blood flow that damages brain tissue (Moini et al., 2023; Ręba, 2020). Ruptures in blood vessels can cause intracerebral or subarachnoid haemorrhages, accounting for around 16% of strokes (Khan et al., 2020; Ręba, 2020). Individuals with ischemic and hemorrhagic strokes experience the same symptoms. At the same time, those with the latter may also have increased headaches, nausea, and non-focal neurological symptoms like stiff neck and loss of consciousness (Alrabghi et al., 2018).

The occurrence of strokes in India ranges from 44 to 843 incidents per 100,000 persons, according to documented statistics. Pakistan obtained its data from hospital-based case series evaluations. Mass Stroke occurrences within Pakistan number about 350,000 annually, according to Elshaikh (2021), while the prevalence rate stands at 250 occurrences per 100,000 citizens. Stroke, alongside transient ischemic attack, impacts approximately 21.8% of adults who are at least 35 years old, according to data from an urban slum in Karachi study (Syed et al., 2022).

Even though there is a lack of data regarding the prevalence of stroke in Bangladesh, one study indicates that there are three cases of stroke for every 1,000 people. Additionally, the estimated stroke rate in each of the South Asian countries varies very little. Records on stroke frequency remain insufficient for the nations of Afghanistan, Nepal, Bhutan, and the Maldives (Isuru et al., 2021).

The research conducted by Ellepola et al. (2022) indicates that risk characteristics overlap substantially between haemorrhagic stroke and ischaemic stroke environments. The link between diabetes and ischemic heart disease remains clear, but researchers debate the impact of blood pressure elevations and tobacco consumption, together with alcohol intake.

The most catastrophic result from a stroke is lower extremity hemiplegia, serving as the primary physical impairment that affects stroke survivors. Stroke recovery success depends on a person's ability to move their paralyzed side and their capacity to perform everyday tasks independently (Maredza, Bertram & Tollman, 2015).

Over half of stroke survivors are reliant, relying on others for assistance even with daily tasks, and the typical outcomes include long-term physical and mental impairment

(Ręba, 2020). Among the survivors of stroke, one-third suffer from permanent disabilities. The prognosis of cerebrovascular accidents depends on the prompt diagnosis of the type, followed by appropriate and timely management (Alrabghi et al., 2018).

Stroke often leads to impaired balance and mobility, significantly impacting functional abilities (Parmar & Gandhi, 2025). Following a stroke, regaining balance is considered crucial and can be influenced by several factors, including restricted joint motion, weakness, tone variation, motor coordination, and sensory organization elements (Saleem, Arora, and Chauhan, 2019).

Motor function alterations caused by CVA, such as the presence of associated reactions, loss of postural control mechanisms, and tone disorders, shift the body's centre of gravity, generating a risk of falls (Jesus et al., 2023). Stroke patients commonly experience balance impairments that significantly affect their functional mobility and increase the risk of falls. These impairments stem from various factors. Among them, Muscle Weakness is a prevalent issue post-stroke, leading to reduced stability and control during movement. Altered coordination affects the ability to maintain balance during dynamic activities (Filippov et al., 2025).

Proprioceptive impairment contributes to gait and balance impairments in patients with stroke (Takahashi et al., 2024). Impaired proprioception and visual-spatial awareness contribute to balance dysfunction (Karunakaran et al., 2024). Deficits in balance and gait can be especially debilitating after a stroke since they make it difficult for the patient to walk safely and independently (Krakauer & Carmichael, 2022, p. 159).

Balance impairments often result in slower mobility, which in turn affects daily activities (Gobezie et al., 2024). Following a minor stroke, there may be ongoing balance issues that increase the risk of falls, decreased activity levels, and fear of falling (Roelofs et al., 2023). Approximately 50% of stroke patients fall within a year, with serious injuries being more common compared to non-stroke individuals (Wang et al., 2025).

Stroke-induced neurological diseases can lead to abnormal functioning in these neural systems, resulting in balance-related movement modifications that affect walking and posture stability, according to Iruthayarajah et al. (2017). Stroke patients experience significant balance deterioration because of multiple motor and sensory dysfunctions caused by the CVA. Liu et al. (2024) established that balance dysfunction affects about 70% of stroke survivors and complicates their daily activities while heightening their potential for falls.

Dual-task interference is higher in stroke patients than in healthy older persons, suggesting subclinical attentional abnormalities that could impede recovery (Lindberg et al., 2024). Rehabilitative results can be enhanced by techniques for monitoring and controlling attentional concentration during dual-task training (Wang, Wang & Hou, 2022).

Cognitive dual-task training (CDTT) has been demonstrated to enhance activation in brain regions such as the prefrontal cortex and premotor cortex, which are significant for managing dual tasks. Dual-task training, which entails performing cognitive and motor tasks simultaneously, can impact brain activation patterns and functional recovery in stroke patients. Engaging in dual tasks may promote neuroplasticity, potentially leading to improved functional recovery (Jung & An, 2024). Meta-analyses show significant pre frontal cortex activation during dual-task walking compared to single-task walking, particularly in chronic stroke patients (Wang et al., 2023).

Valecha et al. (2024) conducted a randomized, double-blinded controlled trial to compare the effectiveness of Dual-Task Training (DTT) and the Motor Relearning Program (MRP) in improving gait and dynamic balance in patients with chronic left hemiplegic stroke. A total of 40 participants were randomly assigned to two groups: DTT ($n = 20$) and MRP ($n = 20$), receiving three sessions per week for 12 weeks. The DTT group demonstrated significantly greater improvements than the MRP group, according to post-intervention results ($p<0.05$). The DTT group decreased TUG duration from 25.6 seconds to 19.8 seconds and increased gait speed from 0.45 m/s to 0.62 m/s. The MRP group, on the other hand, had less improvement. Furthermore, the DTT group showed improved results in every gait parameter, such as longer stride length, shorter cycle times, and greater step length and cadence.

CDTT may help stroke patients regain their balance through a major mechanism called neuroplasticity, which is the brain's ability to reorganize itself by forming new neural connections. Stroke often results in damage to brain areas responsible for motor and cognitive functions, leading to impaired balance and mobility. Feng & Chen (2024) anticipated that cognitive dual-task training (CDTT) may also have a positive influence on cognitive function, in addition to physical rehabilitation. Dual-task training challenges the brain to adapt by engaging both motor and cognitive processes simultaneously, potentially promoting compensatory mechanisms and neural recovery. In a randomized controlled trial (RCT), Hong et al. (2020) found that cognitive task training significantly improved stroke patients' gait and balance skills, as assessed by the Timed Up and Go (TUG) test and the Berg Balance Scale (BBS).

A single-group experimental study was conducted by Rai and Ganvir (2020) to evaluate the effect of two weeks of dual-task training on the gait and balance of stroke patients. For a total of two weeks, 39 stroke patients received dual-task training five days a week. The training involved walking while doing concurrent motor and cognitive activities. Results were measured before and after the intervention using the Berg Balance Scale (BBS) and the Functional Gait Assessment Scale (FGAS). The study results demonstrated significant improvements in gait and balance after the intervention, with FGAS scores rising from 15.35 to 19.33 ($p < 0.0001$) and BBS scores increasing from a mean of 39.87 to 43.61. The study found that stroke patients' functional gait and dynamic balance can be improved by dual-task training. These findings indicate that CDTT can drive neuroplastic changes, even in the early stages of stroke recovery.

Attention and executive function are critical for balance control, as they enable individuals to focus on relevant sensory information and make appropriate motor adjustments. Stroke patients often experience deficits in these cognitive domains, which can impair balance. Cognitive dual task training (CDTT) requires patients to allocate attention between two tasks, potentially improving their ability to prioritize and manage competing demands. Dual-task interference refers to the decline in performance when two tasks are performed simultaneously. Stroke patients often exhibit increased dual-task interference, which can impair balance and gait. CDTT may reduce this interference by improving the brain's ability to manage competing demands. Khan et al. (2022), in their systematic review, emphasized that motor-cognitive dual-task training plays a crucial role in enhancing attentional capacity and flexibility and reducing dual-task interference. This form of training enables individuals to allocate their attentional resources more efficiently, allowing for better management of postural control while simultaneously engaging in cognitively demanding tasks. The improvement in attentional resource allocation is particularly significant for individuals with neurological impairments, such as stroke survivors, as it helps reduce the risk of imbalance and falls during daily activities that require multitasking. The systematic review reported that, after dual-task training, several studies showed a decrease in the incidence of falls and indicated notable improvements in balance.

A pre-post experimental investigation comparing the effects of motor dual-task training (MDTT) and cognitive dual-task training (CDTT) on balance in stroke patients was carried out by Sukala (2021). Thirty patients participated in the trial, and they were randomly divided into two groups of fifteen. The treatment lasted 45 minutes, once a day, five days a week, for four weeks. Participants' ability to balance in cognitive and motor dual-task conditions was evaluated before and after the intervention using the Berg Balance Scale, Stroop test, and Standing Balance Test. Comparing cognitive dual-task training (CDTT) to motor dual-task training (MDTT), the authors discovered that CDTT considerably improved balance. CDTT may assist stroke patients better handle the mental demands of balance control by improving executive function and attention.

CDTT may strengthen these connections, leading to more efficient and adaptive balance control. Zhang et al. (2024) conducted a meta-analysis of randomized clinical trials and found that cognitive-motor dual-task training (CMDT) significantly improved stroke patients' static balance function, as assessed by the Berg Balance Scale (BBS). However, the findings for other metrics, such as the Timed Up and Go (TUG) test, are less clear. Another meta-analysis by Zhang et al. (2022) reported improvements in gait parameters, such as step length and cadence, following dual-task training, suggesting enhanced motor-cognitive coordination. These improvements in motor-cognitive integration likely contribute to better balance outcomes in patients with stroke.

Proprioception, the sense of body position and movement, is essential for maintaining balance. Stroke patients often experience proprioceptive deficits, which can impair balance and gait. Dual-task training, particularly when combined with proprioceptive exercises, can enhance proprioceptive function, resulting in improved balance control. A systematic review highlighted the effectiveness of combining proprioceptive exercises with dual-task training in improving balance and reducing the risk of falls in stroke patients (Chiaramonte et al., 2022). By targeting the proprioceptive system, CDTT may help stroke patients regain their sense of body awareness and stability.

The study by Hong et al. (2020) investigated the effectiveness of cognitive dual-task training on improving balance and gait in stroke patients. In this study, stroke patients were allocated into two groups: one for general task training (GBT) and the other for cognitive balance training (CBT). In order to enhance unconscious-level postural control, participants in the CBT group underwent a four-week dual-task intervention that combined physical activity with cognitive activities based on traffic signals. The results showed that the CBT group improved statistically significantly in a number of categories, including stride velocity, stride length, and double support time; TUG times reduced; and Berg Balance Scale (BBS) scores increased. On the other hand, neither TUG nor gait-related measures changed significantly in the GBT group. By minimizing dual-task interference, CDTT may enhance balance control in stroke patients.

The research by Anandh et al. (2021) demonstrated that performing dual-task exercises on typical ground surfaces, combined with varied terrain, resulted in improved balance performance. People who performed activities involving simultaneous cognitive and motor functions, as well as motor-specific dual tasks, showed better postural control, indicating that attentional resources strongly affect balance performance. Dual-task training may activate and strengthen neural pathways involved in balance and gait. This is particularly important for stroke patients, who often experience damage to these pathways. By engaging both cognitive and motor systems, CDTT may promote the recovery of balance-related neural circuits.

The BBS is particularly effective in identifying balance disabilities, which are common in stroke survivors, and can guide targeted interventions (Sharabiani et al., 2024; Wang et al., 2024; Criekinge et al., 2023). The study by Iranmanesh et al. (2024) investigated different dual-task training methods and found that training with variable priority (shifting attention between tasks) significantly improved cognitive processing and balance performance compared to fixed-priority training. The Berg Balance Scale, a key outcome measure in stroke rehabilitation, was used to assess balance performance, and results demonstrated that dual-task interventions led to better improvements in postural control than single-task exercises. Studies indicate that the BBS can effectively predict fall risk, with machine learning models achieving high accuracy when using subsets of the BBS items (Ta & Jin, 2023).

The TUG test measures the time taken for a patient to stand up, walk three meters, turn, walk back, and sit down, providing insights into mobility and functional independence. Research indicates that longer TUG times are associated with a higher fall risk, making them a valuable tool for clinicians (Criekinge et al., 2023). Studies have shown that dual-task training significantly improves step length, a crucial factor in effective ambulation. Increased cadence has been observed with dual-task interventions, indicating better rhythmic walking patterns (Vecchio et al., 2024; Zhang et al., 2022). Enhanced gait parameters correlate with improved functional mobility, as evidenced by significant gains in assessments like the 10-Meter Walk Test (10MWT) and TUG scores in patients undergoing dual-task training (Valecha et al., 2024; Zhang et al., 2022). Tools like the Berg Balance Scale (BBS) and Timed Up and Go (TUG) test are frequently used to evaluate balance, with dual-task training showing positive effects on these scores. While dual-task training demonstrates promising benefits for gait improvement, some studies indicate that its superiority over conventional training methods remains inconclusive, necessitating further research to solidify these findings (Zhang et al., 2024; Zhang et al., 2022).

The study conducted by Khan et al. (2024) investigated the comparative effectiveness of dual-task training (DTT) and conventional physiotherapy in improving ambulation among right hemiplegic stroke patients. 18 individuals were randomly assigned into two groups for this randomized controlled trial: one group had DTT, which included walking in many directions while holding a sandbag, and the other group received traditional physiotherapy, which included strengthening, stretching, mat exercises, and gait training. Both groups demonstrated functional improvements over four weeks, although the DTT group's improvements were significantly greater across all assessed parameters of gait. Step length, stride length, cadence, cycle time, and performance on the 10-Meter Walk Test (10MWT) and Timed Up and Go (TUG) tests were all significantly improved for the DTT group, with p-values showing high statistical significance ($p < 0.05$).

Many studies report low certainty in their findings, primarily due to small sample sizes and high heterogeneity (Zhang et al., 2024). Most studies lack long-term follow-up, limiting understanding of sustained effects. Further exploration of the long-term effects of CDTT on balance and cognitive function is warranted (Chuang et al., 2024). Trombini-Souza et al. (2023) reported that dual-task exercises improved gait speed, balance, and executive function in older adults, emphasizing the importance of integrating cognitive challenges into rehabilitation programs. While CDTT shows potential for improving balance recovery in stroke patients, the limitations and gaps in current research highlight the need for further investigation to establish more robust evidence and optimize training protocols.

3.1 Study design

A Randomized Controlled Trial (RCT) was employed as the experimental design for the quantitative research investigation to evaluate the efficacy of cognitive dual-task training on balance in patients with stroke.

The study was double-blinded, where the assessor and participants were masked. Participants were randomly allocated to either the experimental group (receiving cognitive dual-task training) or the control group (receiving conventional therapy).

A pre-test (before intervention) and post-test (after intervention) were administered to each subject in both groups to compare balance outcomes before and after the treatment. The design can be shown by-

r o x o (experimental group)

r o o (control group)

3.2 CONSORT Flowchart of the phases of the randomized controlled trial

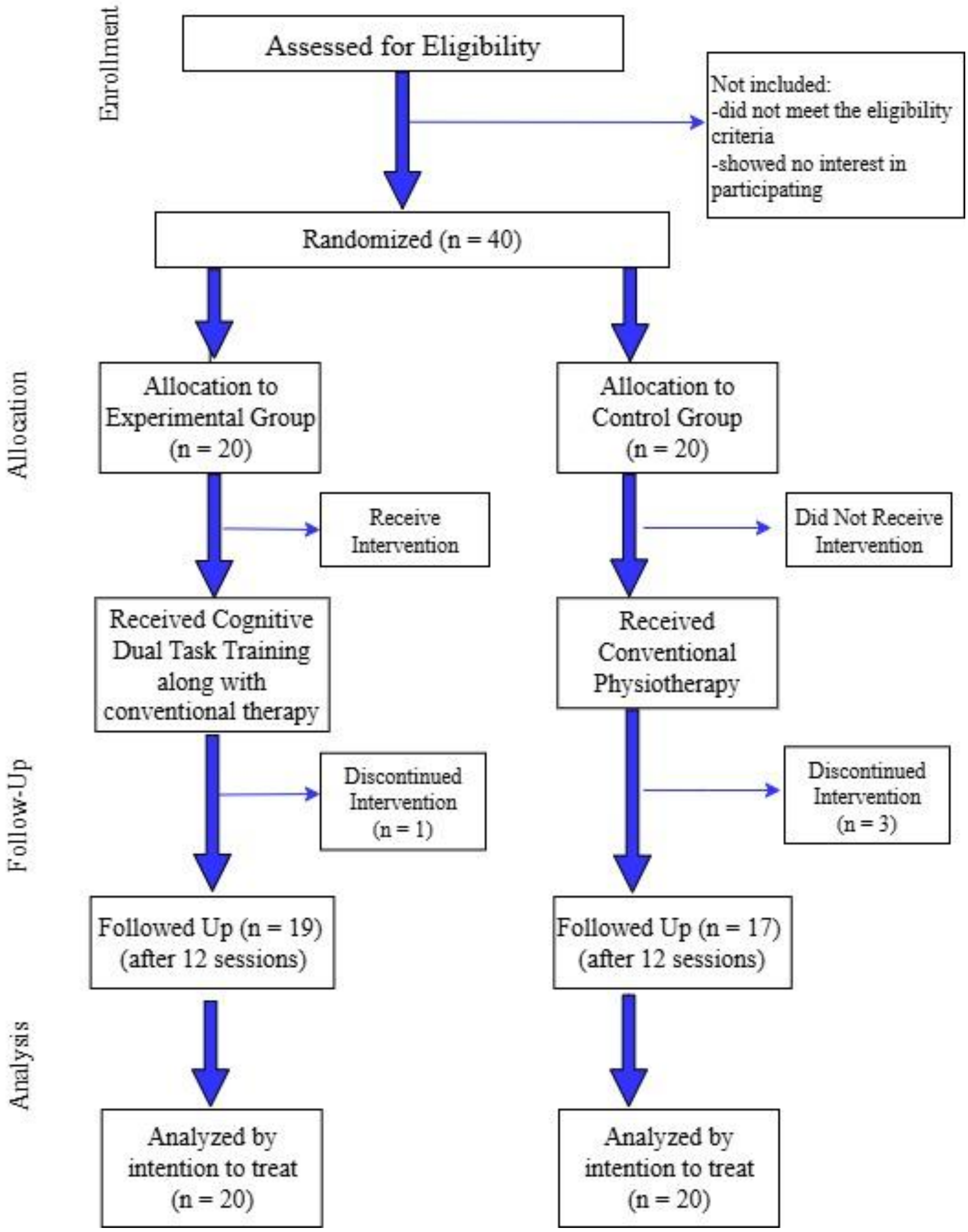


Figure-3.1: Consort flowchart of the study

3.3 Study area

The study was conducted in the Neurology Unit of the Physiotherapy Department at the Centre for the Rehabilitation of the Paralyzed (CRP), Savar, Dhaka.

3.4 Study duration

The study was conducted over approximately one year, from June 1, 2024, to May 31, 2025. This time frame encompassed all stages of the research, from participant recruitment to the dissemination of results. Data collection was conducted over a three-month period, from January 1, 2025, to March 31, 2025.

3.5 Study population

A study population comprises a selection of elements drawn from a target population to comprise the sample (Hu, 2024). In this study, stroke patients receiving rehabilitation services at CRP were selected as the study population.

3.6 Selection criteria

3.6.1 Inclusion criteria:

- Patients with stroke who were receiving rehabilitation services at CRP
- Age between 20 to 80 **(Liu et al., 2017)**
- Both male and female **(Rai & Ganvir, 2020)**
- A score of greater than 24 on the mini-mental state examination (MMSE) **(Liu et al., 2017)**
- Ability to take one or more steps with or without assistance **(Jiejiao et al., 2012)**
- Stable medical condition to allow participation in testing protocol and intervention **(Jiejiao et al., 2012)**

3.6.2 Exclusion criteria:

- Any uncontrolled health condition for which exercise was contraindicated (**Liu et al., 2017)**
- Non-stroke-related sensory or motor impairments **(Jiejiao et al., 2012)**
- Aphasia **(Rai & Ganvir, 2020)**
- Hearing impairment or visual impairment **(Rai & Ganvir, 2020)**
- Seizure disorder **(Rai & Ganvir, 2020)**
- Any other significant neurological or orthopaedic disorder of gait, including amputation **(Rai & Ganvir, 2020)**

3.7 Sample size

G*Power software (version 3.1.9.4) was used to calculate the required sample size for this experimental study. An a priori power analysis using a paired t-test (matched pairs) indicated that a minimum sample size of 36 participants was needed to achieve a statistical power of 95% (0.95), with an effect size of 0.56, as reported by Sengar et al. (2019), using a one-tailed test at a 5% level of significance ($\alpha = 0.05$).

Forty (40) participants (20 individuals per group) with stroke were recruited for this study.

3.8 Sampling procedure

A simple randomization technique was employed to select the sample from the target population, after which participants were randomly allocated into two groups. The study focused on individuals with stroke who met the pre-defined inclusion and exclusion criteria, thereby ensuring the relevance and applicability of the findings. A total of 40 participants were conveniently selected from the population. Group allocation was performed using computer-generated random numbers following the simple random sampling method, which enhances the internal validity of experimental research. As a result, 20 participants were randomly assigned to the experimental group, which received cognitive dual-task training in combination with conventional balance training. The remaining 20 participants, assigned to the control group, received only conventional physiotherapy. The participants allocated to the experimental group were identified by the following numbers: 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 14, 16, 18, 21, 22, 23, 24, 25, 27, and 31. In contrast, the control group comprised participants with identification numbers: 8, 9, 13, 15, 17, 19, 20, 26, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, and 40.

3.9 Method of data collection

A written informed consent was obtained from all participants before data collection. The procedure was performed by the assessor through a structured questionnaire, a face-to-face interview with a closed-ended questionnaire that the researcher formatted to maintain consistency and reliability in data collection. Each participant received a total of 12 treatment sessions. A structured, closed-ended questionnaire was developed by the researcher to collect accurate sociodemographic information regarding each participant's background. Data collection involved three phases: pre-test, intervention, and post-test. Before the commencement of the treatment sessions, a pre-test was conducted to record baseline data on cognitive function, balance, and gait, using a structured questionnaire. The same assessment procedure was repeated following the completion of the 12 treatment sessions.

Cognitive function was assessed using the Mini-Mental State Examination (MMSE) prior to treatment initiation to confirm eligibility based on the inclusion criteria. To minimize potential bias, data collection for both experimental and control groups was conducted by two data collectors in the presence of a qualified physiotherapist. For the convenience and comprehension of participants, the questionnaires were made available in both Bengali and English.

3.10 Data collection tools

An information and consent form, along with a standardized questionnaire, were used as data collection tools.

3.10.1 Questionnaire

The questionnaire was developed in accordance with specific guidelines and with the supervisor's advice and approval. It was designed to gather information related to cognitive function, balance function, walking ability, and personal details of stroke survivors. The key areas it covered include-

I. Socio-demographic information of stroke patients

It typically refers to the basic personal and social characteristics of participants, including age, gender, marital status, education level, employment status, occupation, and living area.

II. Stroke-related information

In this section, details such as the date of stroke onset, stroke type, affected side, time since stroke, number of strokes, and family history of stroke were collected. This information was used to understand better the clinical characteristics and severity of each participant's stroke.

III. Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) is a tool used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment.

3.10.2 Primary outcome measurement

Primary outcome measurements focused on examining functional outcomes such as balance using the Berg Balance Scale (BBS).

3.10.3 Secondary outcome measurement

Secondary outcome measurements included the Risk of fall, mobility, and changes in gait parameters assessed with the Time Up and Go test (TUG), as well as gait parameters such as step length, stride length, gait velocity, and cadence, which will be analyzed to assess gait quality. In addition to being the primary measure of balance, BBS will also serve as a secondary outcome to track changes in fall risk over time.

3.11 Measurement tools

3.11.1 Primary outcome measurement tool

Berg Balance Scale

The Berg Balance Scale (BBS) is a 14-item scale that quantitatively assesses balance function in individuals through various tasks and predicts the risk of falls in patients. The items are scored from 0 to 4, with a score of 0 representing an inability to complete the task and a score of 4 representing independent item achievement. A global score is calculated out of 56 possible points. A score of 41-56 represents low fall risk, 21-40 refers to medium fall risk, and a score of 0-20 represents higher risk of fall. The BBS is widely used to assess fall risk and track changes in balance over time, helping to guide rehabilitation and intervention strategies (Berg et al., 1989).

3.11.2 Secondary outcome measurement tool

Time Up and Go (TUG) test

The Time Up and Go (TUG) test is a relatively simple assessment tool used to evaluate a person's mobility, requiring both static and dynamic balance. It measures the time it takes a person to rise from a chair, walk three meters, turn around 180 degrees, walk back to the chair, and sit down while turning 180 degrees. An older adult who takes 12 seconds or more to complete the TUG is at risk for falling.

Gait Parameters

The Gait Parameter test involves analyzing specific measurable aspects of a person's walking pattern to assess their mobility, stability, and efficiency. It includes step length which refers to the linear distance between the heel strike of one foot and the heel strike of the opposite foot during gait, stride length that represents the distance covered between two successive heel strikes of the same foot, gait speed involves the distance covered per unit of time during walking, measured in meters per second (m/s). and cadence is the number of steps taken per unit of time, usually expressed in steps per minute (steps/min).

3.12. Treatment regime

The study was conducted three days a week for a total of four weeks. Both groups underwent treatment for 30 minutes per day.

3.12.1 Treatment protocol for control group

- Sitting practice
- Standing practice
- Reaching practice
- Ball throwing practice
- Weight shifting exercise
- Weight-bearing exercise
- Single leg stance
- Squatting
- Balance training on a wobble board
- Stepping practice
- Walking forward, backward, sideways
- Gait practice on different surfaces (even or uneven surfaces)

3.12.2 Treatment protocol for experimental group

All patients in the experimental group received cognitive dual-task training for 30 minutes (3 minutes x 10 tasks) while performing conventional balance exercises.

Work station	Description	Dosage and Intensity
Station – 1: **Addition/Subtraction** (Jiejiao et al., 2012)	Answering simple addition and subtraction questions (e.g., 3+2=5, 100-7=93)	3 minutes per session; 3 times a week for 4 weeks
Station – 2: **Counting numbers forward** (Liu et al., 2017)	Counting numbers forward in sequence (e.g. 1, 2, 3, 4, 5…)	3 minutes per session; 3 times a week for 4 weeks
Station – 3: **Counting numbers backward** (Rai & Ganvir, 2020)	Counting numbers backward in sequence (e.g. 10, 9, 8, 7, 6…)	3 minutes per session; 3 times a week for 4 weeks
Station – 4: **Category naming** (Rai & Ganvir, 2020)	Naming as many items as possible within a specific category (e.g., animals, fruits etc.)	3 minutes per session; 3 times a week for 4 weeks
Station – 5: **Word chain execution** (Liu et al., 2017)	Saying a word that begins with the last letter of the previous word (e.g. apple > egg > grape)	3 minutes per session; 3 times a week for 4 weeks
Station – 6: **Poem recitation** (Liu et al., 2017)	Reciting a memorized poem	3 minutes per session; 3 times a week for 4 weeks

Station – 7: **Sentence backward recitation** (Rai & Ganvir, 2020)	Reciting a simple sentence backward (e.g., "The cat sat on the mat" becomes "mat the on sat cat the")	3 minutes per session; 3 times a week for 4 weeks
Station – 8: **Color discerning** (An et al., 2014)	Identifying and naming colors of objects displayed	3 minutes per session; 3 times a week for 4 weeks
Station – 9: **Spelling words backward** (An et al., 2014)	Spelling words backward (e.g., "apple" becomes "elppa")	3 minutes per session; 3 times a week for 4 weeks
Station – 10: **Verbal analogical reasoning** (An et al., 2014)	Solving verbal analogies (e.g., "dog is to bark as cat is to __")	3 minutes per session; 3 times a week for 4 weeks

Figure-3.2: Stepping practice while reciting a poem

Figure-3.3: Walking in a straight line while counting numbers backward

Figure-3.4: Weight transferring practice while executing word chain

Figure 3.5: Walking backward while counting odd numbers backward

3.13 Data analysis

The data collected were analyzed statistically using descriptive statistics for the demographic questionnaire and inferential statistics to examine group differences, employing the Statistical Package for the Social Sciences (SPSS) version 25.0 software. Data were also organized and presented through graphs, charts, and tables using Microsoft Excel and Microsoft Word. The significance level (alpha) was set at 0.05. An intention-to-treat analysis was performed, with missing data managed using the last observation carried forward (LOCF) method.

The normality of the data was assessed using the Shapiro-Wilk test. Baseline characteristics of both groups were compared using the independent samples t-test or the Chi-square test, depending on whether parametric assumptions were met. The results of these tests guided the selection of appropriate statistical methods. For data demonstrating a normal distribution (Timed Up and Go test), paired t-tests were used to analyze within-group pre- and post-intervention changes, and independent t-tests were used to analyze between-group differences. For data exhibiting non-normal distribution (Berg Balance Scale and Gait parameters), the Wilcoxon signed-rank test and Mann-Whitney U test were applied for within-group and between-group analyses, respectively.

3.14 Ethical consideration

Ethical considerations for this study were thoroughly addressed to ensure the protection and well-being of all participants. The research proposal was submitted to the Institutional Review Board (IRB), and approval was obtained under reference number CRP-BHPI/IRB/12/2024/1008 before commencing the study. The guidelines established by the Bangladesh Medical Research Council (BMRC) and the World Health Organization (WHO) were strictly adhered to throughout the research process. Informed consent was obtained from each participant prior to enrollment, ensuring they were fully aware of the study's purpose, objectives, procedures, potential risks, benefits, and the time commitment involved. Participants were assured of their right to withdraw from the study at any time if they did not wish to continue participating. Their safety and confidentiality were also ensured. Regular monitoring and oversight were maintained throughout the study by the researcher to address any ethical concerns that might arise.

3.15 Informed consent

The informed consent process ensured that all the participants were fully aware of their involvement based on their voluntary decision. Each participant was provided with a comprehensive information sheet outlining the study's purpose, procedure, duration, potential risks, benefits, and their right to withdraw at any time if they feel discomfort and discuss their problem with senior authorities. Participants were assured that their information would be anonymized to prevent identification in any reports or publications and would be handled with the highest level of confidentiality. Before written consent, a detailed verbal explanation of the study was given. After receiving and understanding the information, participants were asked to sign a consent form. This form confirmed their willingness to participate in the study.

The results of this study were presented in various bar graphs, pie charts, and tables.

4.1 Socio-demographic related information

Table-4.1: Demographic variables of the experimental and the control group

Variables	Experimental (n=20)	Control (n=20)	P-value
Age			
Mean (SD), years	51.20±11.69	52.00±9.48	$\mathbf{0.813^x}$
Age category			
30-40 years	3 (15%)	1 (5%)	$\mathbf{0.303^y}$
41-50 years	9 (45%)	10 (50%)	
51-60 years	5 (25%)	5 (25%)	
61-70 years	1 (5%)	4 (20%)	
71-80 years	2 (10%)	-	
Gender			
Male	15 (75%)	19 (95%)	$\mathbf{0.077^y}$
Female	5 (25%)	1 (5%)	
Living area			
Rural	14 (70%)	8 (40%)	$\mathbf{0.153^y}$
Urban	4 (20%)	9 (45%)	
Semi urban	2 (10%)	3 (15%)	
Education level			
No formal education	3 (15%)	5 (25%)	$\mathbf{0.801^y}$
Primary	4 (20%)	3 (15%)	
SSC	6 (30%)	4 (20%)	
HSC	3 (15%)	2 (10%)	
Graduate/Post-graduate	4 (20%)	6 (30%)	
Occupation			
Business	3 (15%)	5 (25%)	$\mathbf{0.039^y}$
Service holder	6 (30%)	2 (10%)	
Government job	1 (5%)	13 (65%)	
Private job	4 (20%)	-	
Others	6 (30%)	-	

x: Independent Samples T test, y: chi-square test; SD: Standard Deviation

Table 4.1 indicates that at baseline, no statistically significant differences were identified between the experimental and control groups for most demographic and clinical variables ($p > 0.05$), showing baseline compatibility. However, a significant difference was noted in occupational status ($p = 0.039$), suggesting a potential imbalance in this variable. This variable is not expected to impact the study outcomes, as the intervention and assessments primarily focus on physical and cognitive aspects, rather than being dependent on occupation. Therefore, this imbalance is unlikely to compromise the internal validity of the study.

4.1.1 Age of the participants

The mean age of participants in the experimental group was 51.20 ± 11.69 years, while in the control group it was 52.00 ± 9.48 years. Among total forty (n=40) participants, experimental group (n=20) age range was between '37-80' years and in the control group (n=20), age range was between '38-70' years where majority of the participants in both experimental group (45%) and control group (50%) belonged to the 41-50 years age range. Both groups showed comparable age patterns in their participant demographics.

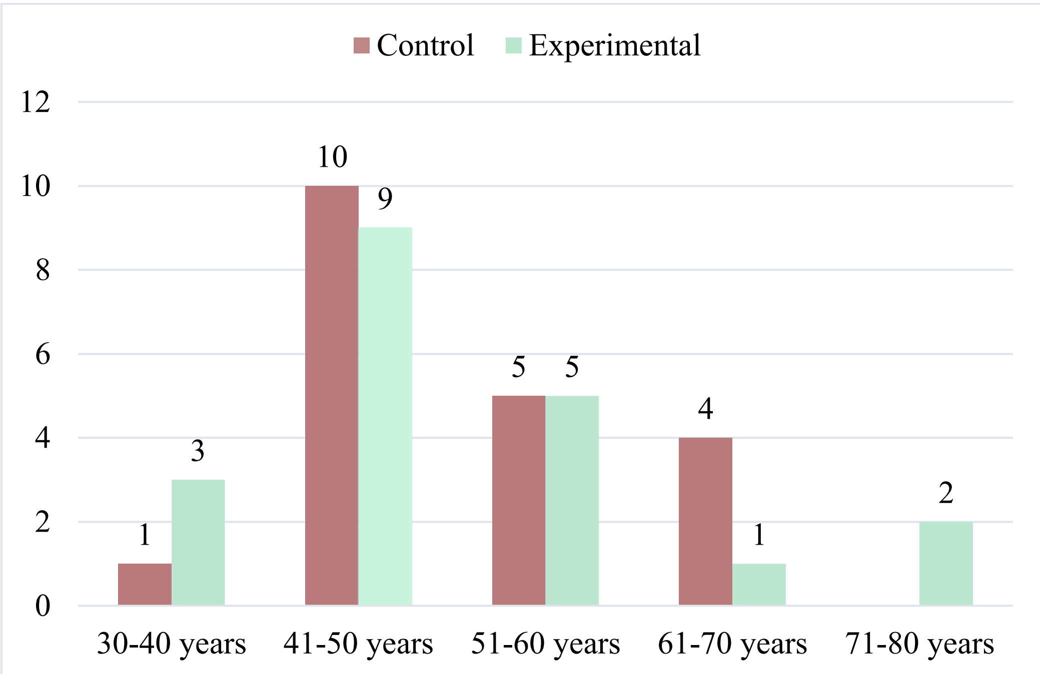


Figure-4.1.1: Age range of stroke participants

4.1.2 Gender ratio of the participants

Among the 40 participants of stroke, 34 participants were male (85%) and 6 participants were female (15%).

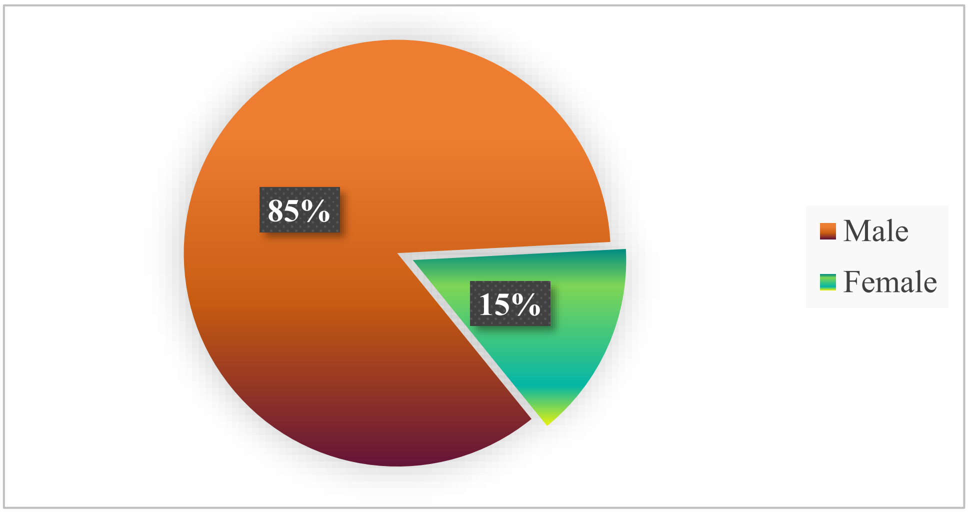
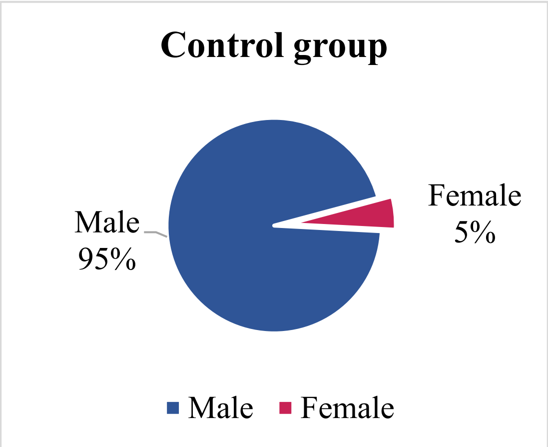


Figure-4.1.2: Gender ratio of the total participants

Conversely, among the 20 participants in the experimental group, 15 (75%) were male and 5 (25%) were female; in the control group, 19 (95%) of the 20 participants were male, and 1 (5%) was female.



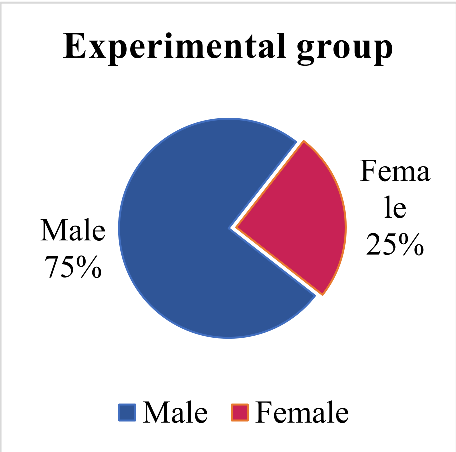


Figure-4.1.2.1: Gender ratio of the participants of the experimental and the control group

4.1.3 Level of education

In the experimental group, the largest number of participants (30%) had completed SSC, whereas in the control group, the majority (30%) were graduates or postgraduates.

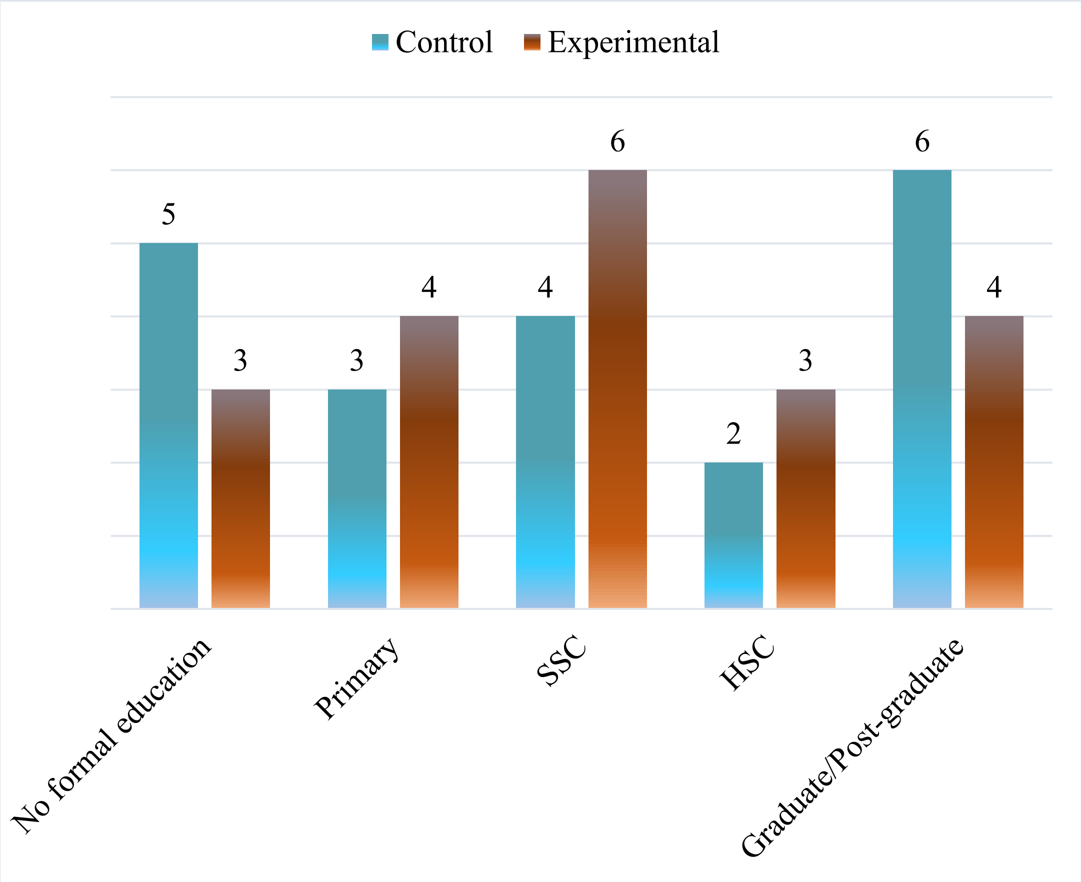


Figure-4.1.3: Level of education among the participants

4.1.4 Occupation

The experimental group consisted of participants from various employment backgrounds, yet the largest number followed service holders (30%) and other roles (30%). The majority of participants in the control group worked as public servants (65%), while no one in their group had private sector or alternative occupational backgrounds.

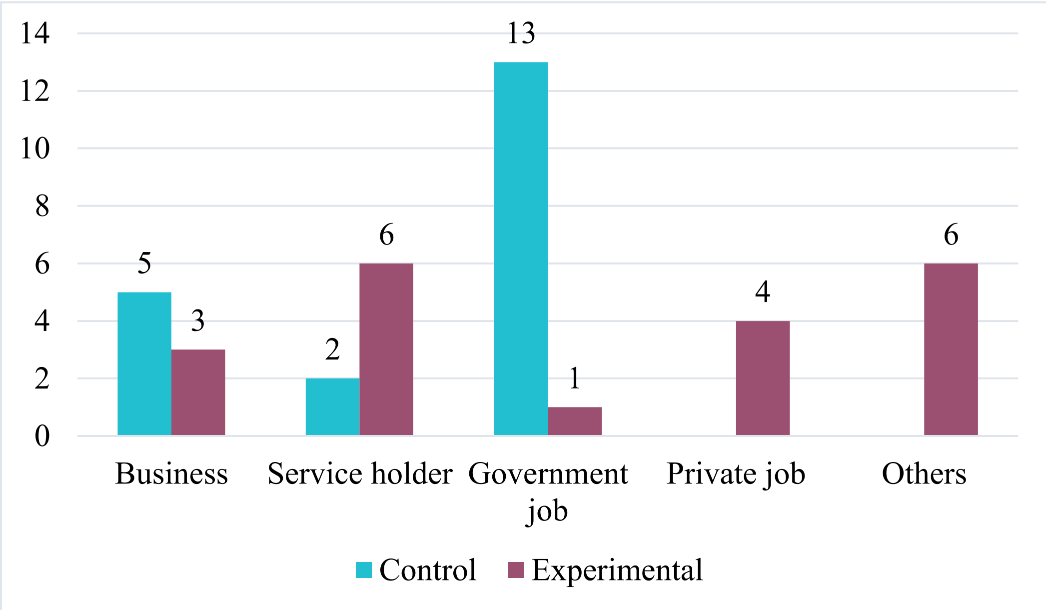


Figure-4.1.4: Occupation among the participants

4.2 Stroke-related information among the participants

Table-4.2: Stroke-related information among the participants

Variable	Experimental	Control	P-value
Stroke duration			
In months, Mean±SD	12.60±13.69	9.90±9.83	$\mathbf{0.478^x}$
Type of stroke			
Ischaemic stroke	19 (95%)	20 (100%)	$\mathbf{0.311^y}$
Haemorrhagic stroke	1 (5%)	-	
Hemiplegia side			
Right	6 (30%)	9 (45%)	$\mathbf{0.327^y}$
Left	14 (70%)	11 (55%)	
Stroke number			
First	17 (85%)	15 (75%)	$\mathbf{0.720^y}$
Second	2 (10%)	3 (15%)	
Multiple	1 (5%)	2 (10%)	
Family history of stroke			
Yes	8 (40%)	7 (35%)	$\mathbf{0.744^y}$
No	12 (60%)	13 (65%)	
MMSE			
Mean±SD	27.05±1.76	27.35±1.59	$\mathbf{0.576^x}$

x: Independent Samples T-test, y: Chi-square test; SD: Standard Deviation

Table-4.2 demonstrates that the experimental and control groups showed no statistically significant differences in stroke-related variables, including stroke duration, type, hemiplegic side, number of strokes, family history, and MMSE scores ($p > 0.05$). This indicates that both groups were comparable at baseline.

4.2.1 Duration of stroke incidence

The mean duration of stroke among participants in the experimental group was 12.60 ± 13.69 months, while in the control group it was 9.90 ± 9.83 months. The analysis revealed no statistically significant difference in stroke duration between the experimental and control groups ($p = 0.478$, $p > 0.05$), indicating that the groups were comparable in terms of stroke chronicity at baseline.

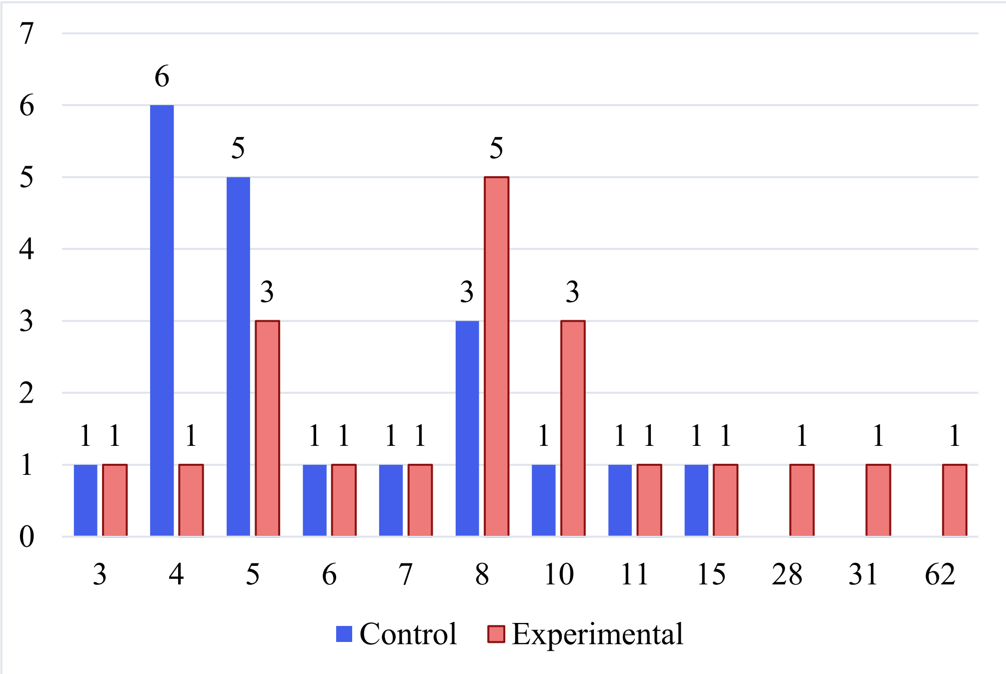


Figure-4.2.1: Stroke incidence duration (in months)

4.2.2 Affected side of the participants

Most participants in the experimental group (70%) presented with left-sided hemiplegia; however, the control group exhibited a balanced distribution (55% left and 45% right hemiplegia).

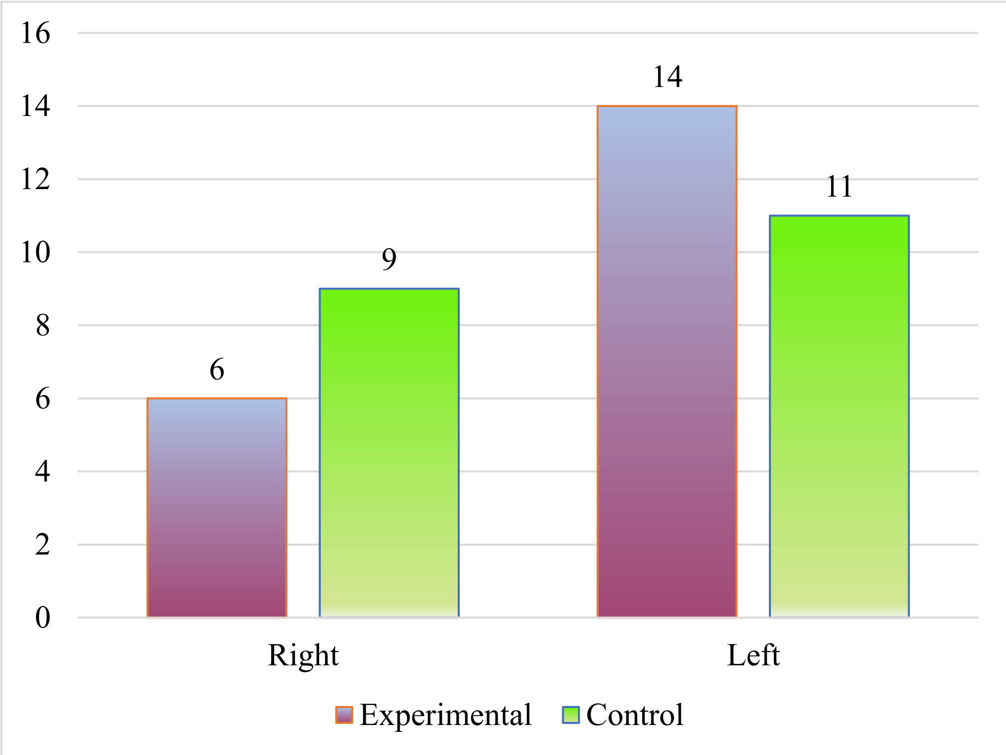


Figure-4.2.2: Affected side of the experimental and control group

4.2.3 Mental status

Both groups exhibited similarly high cognitive function at baseline according to Mini-Mental State Examination (MMSE) scores. The mean MMSE score in the experimental group was 27.05 ± 1.76, while in the control group it was 27.35 ± 1.59. The study results remained unchanged as participants' cognitive statuses demonstrated no significant differences ($p > 0.05$).

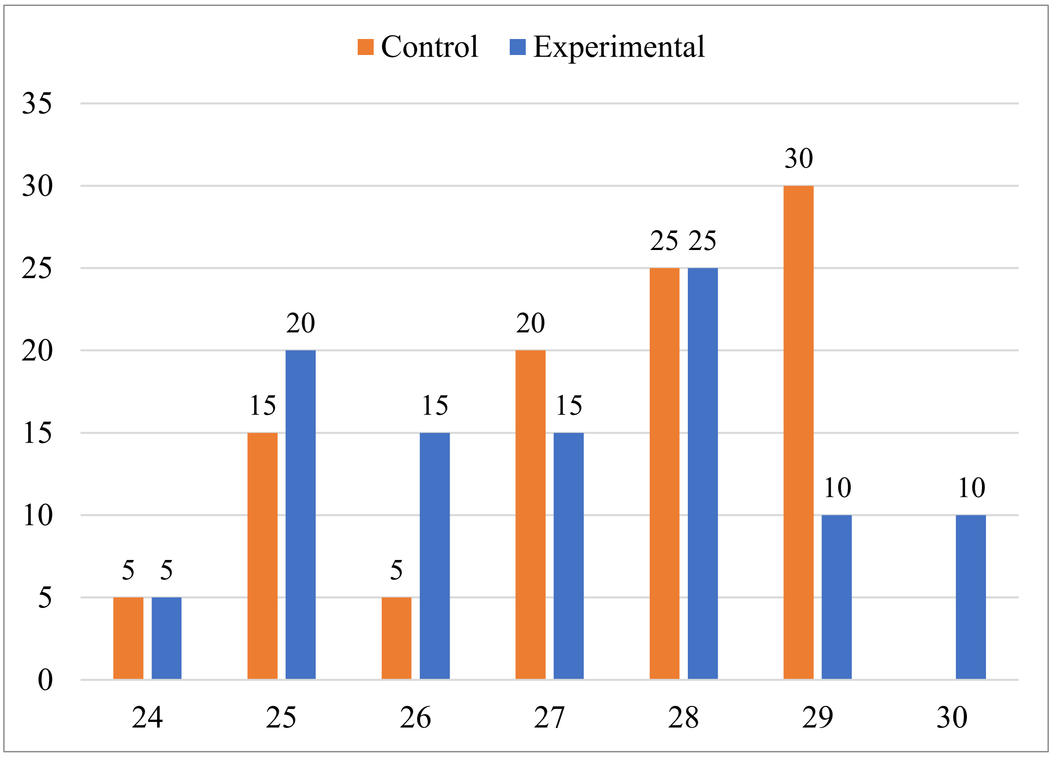


Figure-4.2.3: MMSE score of the participants

4.3 Physical parameters of the participants

Table-4.3: Physical parameter

Variable	Experimental	Control	P value
Weight (kg)			
Mean, SD	68.95±6.917	65.40±10.415	**0.212***
BMI (kg/m²)			
Mean, SD	25.76±3.20	24.87±3.19	**0.382***

***Independent Samples T-test, SD: Standard Deviation**

Table 4.3 shows that no statistically significant differences were found between the experimental and control groups in terms of weight (p = 0.212) and body mass index (BMI) (p = 0.382). This indicates that both groups were comparable in terms of anthropometry at baseline.

4.4 Balance & Gait status

Table-4.4.1: Baseline comparison of BBS, TUG, and gait parameters among stroke participants

Variable	Experimental (n=20)	Control (n=20)	P-value
Pre BBS			
Median (IQR)	41.0 (44.75-38.0)	44.0 (45.75-38.0)	**0.683^z**
Pre TUG (s)			
Mean, SD	32.74±14.0	39.12±36.16	**0.467^x**
Pre Step length (cm)			
Median (IQR)	53.34 (60.45-46.35)	51.43 (63.18-43.18)	**0.924^z**
Pre stride length (cm)			
Median (IQR)	104.14 (120.90-93.13)	102.87 (126.36-86.36)	**0.882^z**
Pre gait speed (m/s)			
Median (IQR)	.3936(.4749-.2853)	.4491(.7936-.3191)	**0.224^z**
Pre cadence (steps/min)			
Median (IQR)	65.0 (75.50-57.0)	69.50 (85.0-53.50)	**0.695^z**

x: Independent Samples T-test; z: Mann-Whitney test; SD: Standard Deviation; IQR: Interquartile Range.

Table 4.4.1 indicates that no significant differences were found between the groups in baseline BBS, TUG, or gait parameters ($p > 0.05$), suggesting that both groups were comparable prior to the intervention.

4.4.1 Berg balance scale (BBS)

Comparison of Berg Balance Scale (BBS) Within Each Group:

- **α (Alpha) Value,** α = 0.05
- **Assumptions**
- Normality test: BBS score is not normally distributed (Shapiro-Wilk test: $p < 0.05$; Histogram showed skewed distribution)
- Sample size < 30.
- Type of variable: Continuous (BBS score).
- **Test used:** Wilcoxon Signed Rank Test (used for paired non-parametric samples)

Table-4.4.2: Pretest-Posttest comparison of Berg Balance Scale (BBS) within each group

Test Statistics (Wilcoxon Signed Rank Test)					
Variable	**Groups**	**Pretest Median (IQR)**	**Posttest Median (IQR)**	**Z-value**	**P-value**
BBS	Experimental	41.0 (44.75-38.0)	48.0 (52.0-45.25)	-3.837	.000*
	Control	44.0 (45.75-38.0)	47.0 (48.75-41.0)	-3.659	.000*

***Significant ($p < 0.05$); IQR: Interquartile Range.**

The Wilcoxon Signed Rank Test was used to analyze pretest and posttest Berg Balance Scale (BBS) scores as part of the within-group assessment for experimental and control group intervention effects. Both groups showed comparable baseline balance because the Mann-Whitney U test revealed no statistically significant difference between them ($p > 0.05$).

In the experimental group (n=20), the median BBS score significantly increased from 41.0 (IQR: 38.0–44.75) at pre-test to 48.0 (IQR: 45.25–52.0) at post-test. This improvement (7.0) was statistically significant, with a Z-value of -3.837 and a p-value of .000 ($p < 0.005$), indicating a strong effect of the intervention.

Similarly, the control group (n=20) showed a significant improvement in BBS scores, increasing from a pretest median of 44.0 (IQR: 38.0–45.75) to a posttest median of 47.0 (IQR: 41.0–48.75). The Wilcoxon Signed Rank Test revealed a Z-value of -3.659 and a p-value of .000, also indicating a statistically significant change.

The experimental participants exhibited a bigger median score change which indicates the cognitive dual-task training might provide better benefits.

Comparison of Berg Balance Scale (BBS) Between Groups

- **α (Alpha) Value,** α = 0.05
- **Assumptions**
- Normality test: BBS score is not normally distributed (Shapiro-Wilk test: $p < 0.05$; Histogram showed skewed distribution)
- Sample size < 30.
- Type of variable: Continuous (Change BBS score).
- **Statistical Test used:** Mann-Whitney U Test (used for comparing independent non-parametric samples)

Table-4.4.3: Pretest-Posttest comparison of Berg Balance Scale (BBS) between groups

Test Statistics (Mann-Whitney U Score)					
Variable	**Groups**	**N**	**Mean rank**	**Z-value**	**P-value**
BBS	Experimental	20	27.53	-3.840	0.000*
	Control	20	13.48		

***Significant (p < 0.05)**

A Mann–Whitney U test was used to assess whether post-intervention balance assessments varied between participants in the experimental and control groups.

The experimental group (n = 20) achieved a higher mean rank (27.53) compared to the control group members (n = 20), who obtained a mean rank of 13.48. However, the between-group analysis demonstrated a statistically significant improvement ($p < 0.05$) in the experimental group compared to the control group, with a Z value of -3.840 and a p-value of 0.000.

The individuals who participated in the experimental group showed significantly more improvements in balance performance compared to the participants in the control group who received conventional therapy.

4.4.2 Fall risk distribution among stroke participants

Fall risk among stroke patients was evaluated using the Berg Balance Scale (BBS), categorizing participants into high (0-20), medium (21–40) and low (41–56) fall risk groups. At baseline, both the experimental group and the control group had identical distributions: 35% (n = 7) of participants in each group were at medium fall risk, and 65% (n = 13) were at low fall risk.

Following the intervention, a shift toward reduced fall risk was observed in both groups. In the experimental group, only 5% (n = 1) remained in the medium fall risk category, while 95% (n = 19) improved to the low fall risk category. In comparison, the control group had 15% (n = 3) in the medium fall risk category and 85% (n = 17) in the low fall risk category.

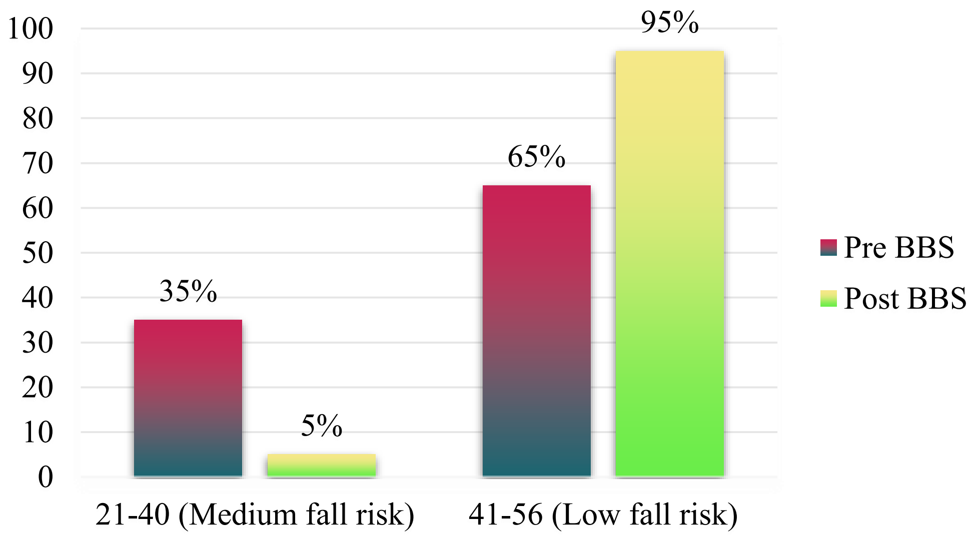


Figure-4.4.1: Pre BBS and Post BBS of the experimental group

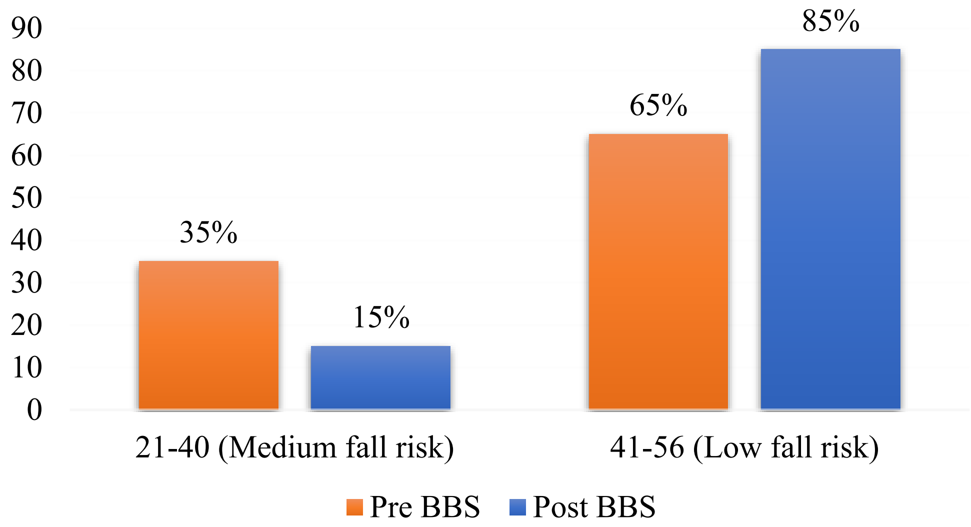


Figure-4.4.2: Pre BBS and Post BBS of the control group

4.4.3 Time Up & Go ((TUG) test

The Independent Sample T-test was used to assess baseline comparability between groups, and no statistically significant difference was found ($p > 0.05$), indicating that both groups were comparable in terms of mobility before the intervention (Table-4.4.1).

Comparison of Time Up and Go test (TUG) Within Each Group:

- **Significance Level (α):** 0.05
- **Assumptions:**
- Normality Test: TUG score is normally distributed (Shapiro-Wilk test: $p > 0.05$; Histogram showed bell-shaped distribution)
- Type of Variable: TUG score measured on a continuous scale
- **Statistical Test Used:** Paired Samples t-test was used to compare pretest and posttest scores within each group, as the assumptions for parametric testing were met

Table-4.4.4: Analysis of pre-test and post-test values of the Time Up and Go test (TUG) for significance within groups.

Test Statistics (Paired Samples T Test)						
Variable	**Groups**	**Pretest Mean±SD**	**Posttest Mean±SD**	**Mean difference**	**t-value**	**P-value**
TUG (s)	Experimental	32.74±14.0	28.01±11.50	4.73	4.10	0.001
	Control	39.12±36.16	37.03±35.66	2.08	3.96	0.001

SD: Standard deviation

The paired samples t-test was performed to evaluate the changes in Timed Up and Go (TUG) test scores before and after the intervention in both the experimental and control groups.

In the experimental group, the mean TUG score decreased from 32.74 ± 14.00 seconds at the pretest to 28.01 ± 11.50 seconds at the posttest. This improvement of 4.73 seconds was statistically significant, with a t-value of 4.10 and a p-value of 0.001 ($p < 0.05$).

The control group also showed a decrease in mean TUG scores, from 39.12 ± 36.16 seconds at the pretest to 37.03 ± 35.66 seconds at the posttest. This change, with a mean difference of 2.08 seconds, was likewise statistically significant ($t = 3.96$, $p = 0.001$).

Although both groups experienced improvements in performance, the experimental group showed a more substantial reduction in TUG time, suggesting that the cognitive dual-task training had a more pronounced effect in that group.

Comparison of the Time Up and Go test (TUG) Between Each Group:

- **Significance Level (α):** 0.05
- **Assumptions:**

- Normality Test: TUG score is normally distributed (Shapiro-Wilk test: $p > 0.05$; Histogram showed bell-shaped distribution)
- Homogeneity of Variance: Equal variances between the groups (Levene's Test: $p > 0.05$)
- Type of Variable: TUG score measured on a continuous scale

- **Statistical Test Used:** The Independent Samples t-test was used to compare pre-post change scores between the experimental and control groups, as all assumptions for parametric testing were met.

Table-4.4.5: Analysis of pre-test and post-test values of the Time Up and Go test (TUG) for significance between groups.

Test Statistics (Independent Samples T Test)				
Variable	**Groups**	**N**	**t-value**	**P-value**
TUG (s)	Experimental	20	2.089	0.043
	Control	20		
	Total	40		

The table presents the results of a between-group analysis using an Independent Samples t-test, indicating a statistically significant difference between the means ($t = 2.089$, $p = .043$). Since the p-value is less than 0.05, the result is statistically significant. So, it can be concluded that the experimental group participants who underwent cognitive dual-task training showed greater improvement in mobility compared to the control group participants.

4.5 Gait parameters

There were no significant differences ($p > 0.05$) between the experimental and control groups for any of the measured gait parameters (step and stride length, gait speed, and cadence) at the baseline evaluation, indicating that both groups were similar in terms of gait characteristics prior to the intervention (Table - 4.4.1).

Table-4.4.6: Analysis of pre-test and post-test values of Gait Parameters for significance within groups using Wilcoxon Signed Rank Test

Groups	Pretest Median (IQR)	Posttest Median (IQR)	Z-value	P-value
Step length (cm)				
Experimental	53.34 (60.45-46.35)	58.42 (63.5-49.53)	-3.733	.000
Control	51.44 (63.18-43.18)	53.34 (64.45-45.33)	-3.069	.002
Stride length (cm)				
Experimental	104.14 (120.90-93.13)	116.84 (127-99.06)	-3.733	.000
Control	102.87 (126.36-86.36)	106.68 (128.90-90.67)	-3.069	.002
Gait speed (m/s)				
Experimental	.3936 (.4749-.2853)	.4435 (.6505-.3345)	-3.724	.000
Control	.4491 (.7936-.3191)	.4482 (.7718-.3316)	-2.556	.011
Cadence (steps/min)				
Experimental	65.0 (75.5-57)	72.5 (84.75-65.75)	-3.336	.001
Control	69.50 (85-53.5)	76 (89.75-55.25)	-3.265	.001

Table-4.4.7: Between-group analysis of Gait Parameters

Test Statistics (Mann-Whitney U Score)				
Groups	**Mean rank**	**Z-value**	**P-value**	**Comment**
Step length (cm)				
Experimental	27.95	-4.071	.000	Significant
Control	13.05			
Stride length (cm)				
Experimental	27.80	-3.989	.000	Significant
Control	13.20			
Gait speed (m/s)				
Experimental	25.73	-2.834	.005	Significant
Control	15.28			
Cadence (steps/min)				
Experimental	27.63	-2.783	.005	Significant
Control	15.38			

4.5.1 Step Length

Within-Group Analysis:

Table-4.4.6 shows that in the experimental group, the median step length increased from 53.34 cm (IQR: 60.45–46.35) at the pretest to 58.42 cm (IQR: 63.5–49.53) at the posttest, with the difference being statistically significant ($p < 0.05$) according to the Wilcoxon Signed Ranks Test ($Z = -3.733$, $p = 0.000$).

Similarly, in the control group, the median step length slightly increased from 51.44 cm (IQR: 63.18–43.18) to 53.34 cm (IQR: 64.45–45.33), and this improvement was also statistically significant ($p < 0.05$) based on the Wilcoxon Signed Ranks Test ($Z = -3.069$, $p = 0.002$).

Between-Group Analysis:

The differences in step length improvements between the experimental and control groups were evaluated using the Mann-Whitney U test, based on the pre- and post-change scores (Table-4.4.7). The results indicated a statistically significant difference between the two groups, favouring the experimental group. Specifically, the experimental group had a mean rank of 27.95, while the control group had a lower mean rank of 13.05. The corresponding Z-value was -4.071, and the p-value was 0.000, indicating a highly significant difference ($p < 0.05$).

4.5.2 Stride Length

Within-Group Analysis:

The measurements of stride length changes within experimental and control groups were analyzed using the Wilcoxon Signed Rank Test (Table-4.4.6).

In the experimental group, the median stride length increased from 104.14 cm (IQR: 120.90-93.13) at pre-intervention to 116.84 cm (IQR: 127-99.06) at post-intervention, with a statistically significant change of 12.7 cm ($Z = -3.733$, $p = 0.000$) as determined by the Wilcoxon Signed Ranks Test ($p < 0.05$).

In the control group, the mean stride length improved from 102.87 cm (IQR: 126.36-86.36) to 106.68 cm (IQR: 128.90-90.67), and this difference (3.81 cm) was also statistically significant according to the Wilcoxon Signed Ranks Test ($p < 0.05$).

Between-Group Analysis:

The Mann-Whitney U test indicated a significant difference in stride length, showing improvements between the experimental and control groups (Table 4.4.7).

The experimental group exhibited a more substantial improvement, as indicated by a mean rank of 27.80, in contrast to 13.20 for the control group. The test produced a Z-value of -3.989 and a p-value of 0.000, affirming a statistically significant difference ($p < 0.05$) in favour of the experimental group.

These findings indicate that participants in the experimental group who received cognitive dual-task training benefited more in terms of enhanced stride length.

4.5.3 Gait Speed

Within-Group Analysis:

Table-4.4.6 demonstrated that in the experimental group, gait speed exhibited a notable improvement, rising from a median of 0.3936 m/s (IQR: 0.4749–0.2853) at pre-intervention to 0.4435 m/s (IQR: 0.6505–0.3345) following the intervention. The Wilcoxon Signed Ranks Test indicated that this increase of 0.0499 m/s was statistically significant ($Z = -3.724$, $p = 0.000$), as the p value was less than 0.05.

The control group also exhibited a slight improvement in gait speed, increasing from 0.4491 m/s (IQR: 0.7936–0.3191) to 0.4482 m/s (IQR: 0.7718–0.3316). Although the change was minimal (-0.0009 m/s), it remained significant ($Z = -2.556$, $p = 0.011$) according to the Wilcoxon Signed Ranks Test ($p < 0.05$).

Between-Group Analysis:

To compare the changes in gait speed between the two groups, a Mann-Whitney U test was performed (Table 4.4.7).

The experimental group demonstrated a greater improvement in gait speed compared to the control group, achieving a higher mean rank of 25.73 versus 15.28 for the control group. This difference was statistically significant ($Z = -2.834$, $p = 0.005$), indicating a favorable outcome for the experimental group compared to the control group.

4.5.4 Cadence

Within-Group Analysis:

The changes in cadence were analyzed in both the experimental and control groups using the Wilcoxon Signed-Rank Test (Table-4.4.6).

In the experimental group, cadence increased significantly from a median of 65.0 steps/min (IQR: 75.5–57) before the intervention to 72.5 steps/min (IQR: 84.75–65.75) after the intervention. This improvement of 7.5 steps/min was statistically significant ($Z = -3.336$, $p = 0.001$).

The control group also exhibited an increase in cadence, from 69.5 steps/min (IQR: 85–53.5) to 76 steps/min (IQR: 89.75–55.25), indicating a change of 6.5 steps/min, which was likewise statistically significant ($Z = -3.265$, $p = 0.001$).

Between-Group Analysis:

The Mann-Whitney U test was employed to compare the change in cadence between the two groups (Table-4.4.7).

The experimental group exhibited a significantly greater improvement in cadence, with a mean rank of 27.63, compared to the control group's mean rank of 15.38. This difference was determined to be statistically significant ($Z = -2.783$, $p = 0.005$), indicating that the experimental group demonstrated more substantial improvement.

Chapter-V	Discussion

5.1 Discussion

The study was done to analyze the effect of cognitive dual-task training on balance and gait in stroke patients, using the Berg Balance Scale (BBS) as the primary outcome measure, the Timed Up and Go (TUG) test, and gait parameters as secondary outcome measures. The results indicated significant improvements in these parameters for participants who received the cognitive dual-task training (experimental group) compared to the control group, which received conventional physiotherapy only. In this study, 20 stroke patients were randomly assigned to the experimental group, and 20 stroke patients were assigned to the control group. Both groups attended 3-4 sessions per week, totaling 12 treatment sessions during the study's intervention period.

The baseline data demonstrate no significant difference between the groups; therefore, both groups were homogeneous, which is an essential component of any clinical trial.

The median difference of the Berg Balance Scale (BBS) indicates that the experimental group's balance improved more than that of the control group within the same group, and a statistically significant difference was observed between the groups. The study was statistically evaluated using the Wilcoxon signed rank and Mann-Whitney U tests.

The mean change score on the TUG shows that the experimental group (4.73 seconds) significantly reduced TUG time compared to the control group (2.08 seconds) within the groups. There were also statistically significant differences between the groups. The data was statistically analyzed using paired t-tests and independent t-tests.

The findings of this study align with previous research on dual-task training (cognitive and exercise tasks) aimed at improving balance and gait in chronic stroke patients. Both groups, each comprising 9 participants, adhered to the same exercise programme for 45 minutes, three times a week, over a period of four weeks, with the experimental group incorporating additional cognitive tasks. The experimental group exhibited significantly greater improvements than the control group on the Berg Balance Scale ($Z = -2.268$, $p < 0.05$) and the Timed Up and Go (TUG) Test ($Z = -2.87$, $p < 0.05$), reinforcing the effectiveness of dual-task training in enhancing balance and gait performance (Jung & Won, 2014).

Sukala (2021) also reported that cognitive dual-task training is more effective ($p \leq 0.001$) in improving balance, as measured by the BBS, Stroop test, and standing balance, in acute stroke patients with balance impairment, compared to motor dual-task training.

The evaluation of gait parameters in the present study, including step length, stride length, gait speed, and cadence, revealed significant improvements in both the experimental and control groups following the intervention. In the experimental group, step length increased from 53.34 cm to 58.42 cm ($p = 0.000$), stride length improved from 104.14 cm to 116.84 cm ($p = 0.000$), gait speed enhanced from 0.3936 m/s to 0.4435 m/s ($p = 0.000$), and cadence increased from 65.0 steps/min to 72.5 steps/min ($p = 0.001$). These improvements were significantly greater than those observed in the control group, which exhibited smaller gains in these parameters. Both the experimental and control groups showed statistically significant differences within their respective groups ($p < 0.05$), as analyzed using the Wilcoxon signed-rank test. Between-group analysis employing the Mann-Whitney U test confirmed that the experimental group demonstrated greater improvements in all gait measures, with p-values less than 0.05.

The significant improvements in these outcome measures reflect findings from Hong, Moon, & Choi (2020), in which eight subjects participated in the CBT (Cognitive Balance Task training) group and nine in the GBT (General Balance Task training) group. In both groups, the intervention was conducted for 30 minutes a day, three times a week, for four weeks. In their study, following the intervention, the Berg Balance Scale (BBS) increased in both groups (CBT: 4.63, GBT: 7.12, $p<0.05$). The TUG score significantly decreased in the CBT group (6.17s, $p<0.05$). The stride velocity and stride length also improved in the CBT group (stride velocity: 37.47±34.11 cm/s to 40.57±34.98 cm/s, $p<0.05$; stride length: 61.22±23.52 cm to 63.46±22.93 cm, $p<0.05$). In contrast, the GBT group showed improvements that were not statistically significant.

In a single-group experimental study conducted by Rai and Ganvir (2020), the effects of two weeks of dual-task training on balance and gait were evaluated among stroke patients. The study revealed significant improvements in balance and gait, as demonstrated by the Berg Balance Scale ($t = 7.71$, $p < 0.0001$) and the Functional Gait Assessment Scale ($t = 6.57$, $p < 0.0001$).

Khan et al. (2024) conducted a randomized controlled trial to assess the effectiveness of Dual-Task Training (DTT) compared to conventional physical therapy in improving spatial and temporal variables in chronic right hemiplegic stroke. In their study, the treatment group (TG), comprising nine participants, received dual-task training, while the control group (CG), also comprising nine participants, underwent conventional physiotherapy for 30 minutes, four times a week, over a four-week period. In the treatment group (TG), step length significantly increased from 48.40±3.5 cm to 55.44±9.4 cm ($p = 0.001$), and stride length improved from 96±7.2 cm to 102±8.1 cm ($p = 0.01$). Gait speed, measured using the 10-Metre Walk Test (10MWT), showed a significant increase from 85.24±10.20 cm/s to 103.38±8.27 cm/s ($p = 0.001$), and cadence rose from 95.50±3.44 steps/min to 103.60±4.44 steps/min ($p = 0.001$). Furthermore, the Time Up and Go (TUG) test demonstrated a significant decrease in time, from 25.14 ± 2.3 s to 10.15 ± 2.9 s ($p = 0.001$). In contrast, the control group (CG) displayed smaller, non-significant improvements in these parameters. The study revealed significant enhancements in gait parameters following dual-task training (DTT) compared to conventional physical therapy.

In the current study, both the experimental and control groups exhibited significant improvements in gait parameters. However, the experimental group demonstrated more pronounced gains across all measures. The mean difference in pre- and post-intervention TUG scores was notably higher in the experimental group, indicating greater enhancements in mobility. Similarly, the median differences in step length, stride length, gait speed, and cadence were all greater in the experimental group compared to the control group. These results suggest that while both groups achieved positive outcomes, cognitive dual-task training in the experimental group resulted in more substantial improvements in gait and mobility, leading to enhanced overall functional recovery in stroke patients.

Valecha et al. (2024) revealed in their study that the DTT group experienced a significant reduction in TUG time ($p<0.05$), decreasing from 25.6±3.1s to 19.8±2.5s, alongside a marked increase in step length, stride length, cadence, and gait speed ($p<0.05$). The MRP group also showed improvements, though the changes were less pronounced. They reported that dual task training significantly enhances the dynamic balance and gait of chronic stroke patients compared to MRP.

Liu et al. (2017) found that stride length ($p = 0.021$), gait speed ($p = 0.028$), and cadence ($p = 0.011$) were improved in the CDTT group after 30 minutes of cognitive dual-task training over 12 sessions. They suggested that various types of dual-task gait training could be employed to enhance different aspects of dual-task gait performance in patients with stroke.

Training for repetitive tasks to effectively practice daily life significantly improves the neural structure and functional status of post-stroke patients. The current cognitive dual-task training involves performing cognitive and motor tasks simultaneously, which may alter brain activation patterns and enhance functional recovery in stroke patients.

Previous studies supported that balance training could reverse the deterioration of balance function. Another study suggested that incorporating both motor and cognitive tasks as dual-task training significantly improves balance and daily living abilities in stroke patients (Sengar et al., 2019; Her et al., 2011; McCulloch, 2007).

The relationship between cognition and motor control has been a central focus of studies on dual tasks because it is critical for understanding how motor control is restored following central nervous system injury. Sim and Oh (2015) suggested that dual-task training, which involves cognitive effort, is effective in improving walking and balance functions in patients with chronic stroke. They demonstrated that the experimental group, which engaged in dual-task training with cognitive effort, exhibited significant improvements across all variables, including BBS, TUG, gait speed measured by 10MWT, and the 6-minute walk test ($p<0.05$). In contrast, the control group, which underwent single-task training, only showed improvements in the 6-minute walk test and the Berg Balance Scale ($p < 0.05$). Both groups participated in the intervention three times a week for 30 minutes over 4 weeks.

Studies have shown that dual-task training is more effective than single-task training in improving balance in older adults. This method engages cognitive and motor tasks, emphasizing the role of attentional resources in sensory-motor processing, which is vital for motor control. By integrating cognitive and motor functions, dual-task training enhances balance and overall mobility (Buragadda et al., 2012).

Verghese et al. (2010) conducted a study to examine the effect of cognitive remediation on gait in sedentary seniors and suggested that cognitive remediation enhances mobility in older adults. According to the task-integration hypothesis, practicing two tasks together enables participants to develop task coordination skills (Li et al., 2010; Silsupadol et al., 2006).

Sengar et al. (2019) demonstrated that implementing individualized dual-task training in conjunction with traditional interventions, including various cognitive tasks, is feasible for patients with chronic stroke. Within-group analysis indicated significant improvements in gait speed, stride length, and step length following dual-task training, particularly when variable priority instructional sets were employed.

In our daily routines, we frequently engage in dual cognitive tasks, such as talking while walking, transferring objects between hands while conversing, cooking while on the phone, or giving lectures while standing. The results of our study indicate that dual-task training leads to significant improvements in balance and gait, which is consistent with findings from previous studies. This improvement can be attributed to the nature of dual-task training, which closely mimics the functional activities patients encounter in daily life. As a result, the enhancements observed in the Berg Balance Scale, TUG, and gait parameters after 12 sessions of cognitive dual-task training highlight a meaningful functional improvement in balance and gait.

5.2 Limitations of the study:

Despite certain strengths, the study had several limitations, including a small sample size, which may affect its generalizability to the entire population. The researcher sought assistance from two assessors for data collection, which may have potentially influenced the results. Furthermore, there has been no research conducted on this matter in Bangladesh, resulting in a scarcity of relevant information regarding stroke patients receiving specific cognitive dual-task training interventions within this context. Another limitation of the study was the wide age range of subjects, which spanned from 37 to 80 years. Consequently, the results could not be generalized to specific age groups. Additionally, there is a lack of long-term follow-up to evaluate the sustained effectiveness of the intervention. Without such monitoring, it remains uncertain whether improvements in balance and gait performance are retained over time or if the benefits wane following the intervention. Therefore, further research with extended follow-up periods is crucial to assess the long-term impact and sustainability of cognitive dual-task training in conjunction with conventional physiotherapy for stroke patients.

Chapter-VI	Conclusions and Recommendations

6.1 Conclusion

The results of this study highlight the efficacy of cognitive dual-task training in improving balance and gait performance in stroke patients. Although within-group analysis showed a significant improvement, the between-group analysis findings clearly indicated that cognitive dual-task training, combined with conventional physiotherapy, is a more effective therapeutic approach for patients with stroke than conventional physiotherapy alone.

6.2 Recommendations

- The study period was so short that future studies will need more time to complete.
- Future studies involving larger sample sizes are essential to verify the generalizability of these findings
- Extended follow-up periods should be included.
- Need more exercise included
- To generalize the result, a sample should be collected from various hospitals, clinics, institutes, and organizations in different districts of Bangladesh.
- In order to formulate a concrete treatment plan, unusually large and high-quality RCTs are mandatory.

References

Alam, M.B., Saha, U.K., Mashreky, S.R., Hussain, A.E., Haque, M.A., Rahman, A.F., Dalal, K. and Mohammad, Q.D. (2023), 'Health-seeking behaviour of stroke patients in a rural area of Bangladesh', *Bangabandhu Sheikh Mujib Medical University Journal*, *16*(2), pp.75-80.

Alrabghi, L., Alnemari, R., Aloteebi, R., Alshammari, H., Ayyad, M., Al Ibrahim, M., Alotayfi, M., Bugshan, T., Alfaifi, A. and Aljuwayd, H. (2018), 'Stroke types and management', *Int J Community Med Public Health*, *5*(9), p.3715.

Anandh, S., Varadharajulu, G., Alate, M.M. and Mane, D.A. (2021), 'Effect of dual task training on balance and gait over regular and diversified land surfaces in independent elderly', *Int. J. Curr. Sci*, *13*, pp.165-168.

Anita, A. and Zoran, A. (2019), 'Acute Ischemic or Hemorrhagic Stroke Syndromes', *Fungal Infections of the Central Nervous System: Pathogens, Diagnosis, and Management*, pp.335-343.

Buragadda, S., Alyaemni, A., Melam, G.R. and Alghamdi, M.A. (2012), 'Effect of dualtask training (fixed priority-versus-variable priority) for improving balance in older adults', *World Appl Sci J*, *20*(6), pp.884-888.

Chiaramonte, R., Bonfiglio, M., Leonforte, P., Coltraro, G.L., Guerrera, C.S. and Vecchio, M. (2022), 'Proprioceptive and dual-task training: the key of stroke rehabilitation, a systematic review', *Journal of functional morphology and kinesiology*, *7*(3), p.53.

Cho, J., Ha, S., Lee, J., Kim, M. and Kim, H. (2024), 'Stroke walking and balance characteristics via principal component analysis', *Scientific Reports*, *14*(1), p.10465.

Chuang, L.L., Hsu, A.L., Lin, Y.H., Yu, M.H., Hu, G.C., Ou, Y.C. and Wong, A.M.K. (2024), 'Multimodal training with dual-task enhances immediate and retained effects on dual-task effects of gait speed not by cognitive-motor trade-offs in stroke survivors: a randomized controlled trial', *Disability and Rehabilitation*, pp.1-10.

Ellepola, S., Nadeesha, N., Jayawickrama, I., Wijesundara, A., Karunathilaka, N. and Jayasekara, P. (2022), 'Quality of life and physical activities of daily living among stroke survivors; cross-sectional study', *Nursing Open*, *9*(3), pp.1635-1642.

Elshaikh, M.Y. (2021), 'Detection of neuron specific enolase asa diagnostic biomarker and its correlation to functional neurological outcome in acute ischemic stroke', *ALEXMED ePosters*, *3*(3), pp.13-14.

Fartushna, O.Y. and Vinychuk, S.M. (2017), 'Brain injury in patients with acute TIA: clinical features in different TIA subtypes', *Международный неврологический журнал*, (3 (89)), pp.13-18.

Feigin, V.L., Brainin, M., Norrving, B., Martins, S., Sacco, R.L., Hacke, W., Fisher, M., Pandian, J. and Lindsay, P. (2022), 'World Stroke Organization (WSO): global stroke fact sheet 2022', *International Journal of Stroke*, *17*(1), pp.18-29.

Feigin, V.L., Norrving, B., George, M.G., Foltz, J.L., Roth, G.A. and Mensah, G.A. (2016), 'Prevention of stroke: a strategic global imperative', *Nature Reviews Neurology*, *12*(9), pp.501-512.

Feng, Q.M. and Chen, J.W. (2024), 'Effects of exercise combined with cognitive dual-task training on cognitive function and sustained effects in stroke patients: a systematic review and meta-analysis', *Disability and Rehabilitation*, pp.1-10.

Filippov, M.S., Pogonchenkova, I.V., Lutokhin, G.M. and Majorov, E.A. (2024), 'Biomechanical aspects of gait impairments after stroke: an analytical review', *Russian Journal of Physiotherapy, Balneology and Rehabilitation*, *23*(4), pp.205-217.https://doi.org/10.17816/rjpbr640864

French, B., Thomas, L.H., Leathley, M.J., Sutton, C.J., McAdam, J., Forster, A., Langhorne, P., Price, C., Walker, A. and Watkins, C.L. (2010), 'Does repetitive task training improve functional activity after stroke? A Cochrane systematic review and meta-analysis', *Journal of rehabilitation medicine: official journal of the UEMS European Board of Physical and Rehabilitation Medicine*, *42*(1), pp.9-14.

Gobezie, M., Kassa, T., Suliman, J., Eriku, G.A., Takele, M.D., Bitew, D.A., Wubante, S.M. and Kibret, A.K. (2024), 'Balance impairment and associated factors among stroke survivors in public hospitals of Amhara regional state: a multicenter cross-sectional study', *BMC neurology*, *24*(1), p.387.

He, Y., Yang, L., Yang, L., Zhou, J., Yao, L., & Pang, M. Y. C. (2018), 'Dual-task training effects on motor and cognitive functional abilities in individuals with stroke: a systematic review', *Clinical Rehabilitation*, *32*(7), 865–877. https://doi.org/10.1177/0269215518758482

Her, J.G., Park, K.D., Yang, Y., Ko, T., Kim, H., Lee, J., Woo, J.H. and Ko, J. (2011), 'Effects of balance training with various dual-task conditions on stroke patients', *Journal of Physical Therapy Science*, *23*(5), pp.713-717.

Hilkens, N. A., Casolla, B., Leung, T. W., & Leeuw, F. D. (2024), 'Stroke', *The Lancet*. https://doi.org/10.1016/s0140-6736(24)00642-1

Hong, S.Y., Moon, Y. and Choi, J.D. (2020), 'Effects of cognitive task training on dynamic balance and gait of patients with stroke: a preliminary randomized controlled study', *Medical science monitor basic research*, *26*, pp.e925264-1.

Iranmanesh, H., Shirvani, H., Amini, A., Shamsoddini, A. and Sobhani, V. (2024), 'the Effect different type of dual task balance training on balance and cognitive function of older adults', *Journal of Kerman University of Medical Sciences*, *31*(2), pp.79-86.

Iruthayarajah, J., McIntyre, A., Cotoi, A., Macaluso, S. and Teasell, R. (2017), 'The use of virtual reality for balance among individuals with chronic stroke: a systematic review and meta-analysis', *Topics in stroke rehabilitation*, *24*(1), pp.68-79.

Isuru, A., Hapangama, A., Ediriweera, D., Samarasinghe, L., Fonseka, M. and Ranawaka, U. (2021), 'Prevalence and predictors of new onset depression in the acute phase of stroke', *Asian journal of psychiatry*, *59*, p.102636.

Jiejiao, Z., Xueqiang, W., Yueying, X., Ying, Y., Liyan, S. and Zhenwen, L. (2012), 'Cognitive dual-task training improves balance function in patients with stroke', *HealthMED*, *6*(3), pp.840-845.

Jung, S. and An, C.S. (2024), 'A Systematic Review of Cortical Excitability during Dual-Task in Post-Stroke Patients', *Physical Therapy Rehabilitation Science*, *13*(2), pp.213-222.

Jung, S.R. and Won, J.I. (2014), ‘Effects of dual-task training on balance and gait performance in patients with stroke’, *Physical Therapy Korea*, *21*(2), pp.18-27.

Karunakaran, K.K., Pamula, S., Tendolkar, P., Chen, P. and Suviseshamuthu, E.S. (2024), July, ‘Preliminary Validation of an Objective Fall-Risk Assessment for Individuals with Stroke’, In *2024 46th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)* (pp. 1-4). IEEE.

Khan, M. D., Chaughtai, Z., Qazi, S., Taj, S., Pervaiz, H., Irshad, K., Bukhari, S. M. A., Afraz, S., & Kamran, M. T. (2020), ‘Types and clinical presentation of stroke’, *International Journal of Research in Medical Sciences*, *8*(5), 1784. https://doi.org/10.18203/2320-6012.IJRMS20201927

Khan, M., Rahman, S. and Muslim, I. (2024), ‘Dual-Task Specific Training or Conventional Physiotherapeutic Interventions, Which one is more Effective?’, *Journal of Saidu Medical College*, *14*(2), pp.109-114.

Khan, M.J., Kannan, P., Wong, T.W.L., Fong, K.N. and Winser, S.J. (2022), ‘A systematic review exploring the theories underlying the improvement of balance and reduction in falls following dual-task training among older adults’, *International journal of environmental research and public health*, *19*(24), p.16890.

Kim, E., Lee, G., Lee, J. and Kim, Y.H. (2024), ‘Simultaneous high-definition transcranial direct current stimulation and robot-assisted gait training in stroke patients’, *Scientific Reports*, *14*(1), p.4483.

lance Abdollahi, M., Kuber, P.M. and Rashedi, E. (2024), ‘Dual Tasking Affects the Outcomes of Instrumented Timed up and Go, Sit-to-Stand, Balance, and 10-Meter Walk Tests in Stroke Survivors’, *Sensors*, *24*(10), p.2996.

Li, K.Z., Roudaia, E., Lussier, M., Bherer, L., Leroux, A. and McKinley, P.A. (2010), ‘Benefits of cognitive dual-task training on balance performance in healthy older adults’, *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, *65*(12), pp.1344-1352.

Lindberg, P.G., AmirShemiraniha, N., Krewer, C., Maier, M.A. and Hermsdörfer, J. (2024), ‘Increased dual-task interference during upper limb movements in stroke exceeding that found in aging–a systematic review and meta-analysis', *Frontiers in Neurology*, *15*, p.1375152.

Lindsay, M.P., Norrving, B., Sacco, R.L., Brainin, M., Hacke, W., Martins, S., Pandian, J. and Feigin, V. (2019), 'World Stroke Organization (WSO): global stroke fact sheet 2019'.

Liu, Y. C., Yang, Y. R., Tsai, Y. A., & Wang, R. Y. (2017), 'Cognitive and motor dual task gait training improve dual task gait performance after stroke - A randomized controlled pilot trial', *Scientific Reports*, *7*(1), 4070. https://doi.org/10.1038/S41598-017-04165-Y

Liu, Y., Lin, R., Tian, X., Wang, J., Tao, Y. and Zhu, N. (2024), 'Effects of VR task-oriented training combined with rTMS on balance function and brain plasticity in stroke patients: a randomized controlled trial study protocol', *Trials*, 25(1), p.702.

Maredza, M., Bertram, M.Y. and Tollman, S.M. (2015), 'Disease burden of stroke in rural South Africa: an estimate of incidence, mortality and disability adjusted life years', *BMC neurology*, *15*, pp.1-12.

McCulloch, K. (2007), 'Attention and dual-task conditions: physical therapy implications for individuals with acquired brain injury', *Journal of Neurologic Physical Therapy*, *31*(3), pp.104-118.

Murphy, S.J. and Werring, D.J. (2020), 'Stroke: causes and clinical features', *Medicine*, *48*(9), pp.561-566.

Park, M.-O., & Lee, S.-H. (2019), 'Effect of a dual-task program with different cognitive tasks applied to stroke patients: A pilot randomized controlled trial', *NeuroRehabilitation*, *44*(2), 239–249. https://doi.org/10.3233/NRE-182563

Parmar, M.J. and Gandhi, N.V. (2025), 'The Relationship between Balance and Mobility in Poststroke Survivors: A Narrative Review', *Journal of Society of Indian Physiotherapists*, pp.10-4103.

Pendlebury, S.T. and Rothwell, P.M. (2019), 'Incidence and prevalence of dementia associated with transient ischaemic attack and stroke: analysis of the population-based Oxford Vascular Study', *The Lancet Neurology*, *18*(3), pp.248-258.

Raghunadh, N., Swathi, G., & Kumar, T. S. (2022), 'Effectiveness of Dual Task Exercises on Community Ambulation in Hemiparetic Patients', *International Journal of Science and Healthcare Research*, *7*(2), 272–281. https://doi.org/10.52403/ijshr.20220439

Rahman, M.M., Ripan, R.C., Sarker, F., Chowdhury, M.H., Islam, A.N. and Mamun, K.A. (2022), 'September. Prevalence of Stroke in Rural Bangladesh: A Population Based Study', In *International Conference on Machine Intelligence and Emerging Technologies* (pp. 515-523). Cham: Springer Nature Switzerland.

Rai, S., & Ganvir, S. (2019), 'Dual Task Training in Patients with Stroke for Improving Balance and Gait: A Systematic Review', *International Journal of Health Sciences and Research*, *9*(1), 287–295. https://www.ijhsr.org/IJHSR_Vol.9_Issue.1_Jan2019/43.pdf

Rai, S.S. and Ganvir, S.S. (2020), 'Effect of 2 Weeks of Dual Task Training on Balance and Gait in Patients with Stroke: Single Group Experimental Study', *Int J Health Sci Res*, *10*(2), pp.57-66.

Ręba, P. (2020), 'Stroke-diagnosis and treatment methods', *Journal of Education, Health and Sport*, *10*(5), pp.169-174.

Roelofs, J.M., Zandvliet, S.B., Schut, I.M., Huisinga, A.C., Schouten, A.C., Hendricks, H.T., de Kam, D., Aerden, L.A., Bussmann, J.B., Geurts, A.C. and Weerdesteyn, V. (2023), 'Mild stroke, serious problems: limitations in balance and gait capacity and the impact on fall rate, and physical activity', *Neurorehabilitation and neural repair*, *37*(11-12), pp.786-798.

Sadat, A., Podder, V. and Biswas, R. (2023), 'Stroke Strikes in Bangladesh: Current Insights and Future Directions', *Cureus*, *15*(4).

Saraiva, J., Rosa, G., Fernandes, S. and Fernandes, J.B. (2023), 'Current Trends in Balance Rehabilitation for Stroke Survivors: A Scoping Review of Experimental Studies', *International journal of environmental research and public health*, *20*(19), p.6829.

Sengar, S., Raghav, D., Verma, M., Alghadir, A.H. and Iqbal, A. (2019), 'Efficacy of dual-task training with two different priorities instructional sets on gait parameters in patients with chronic stroke', *Neuropsychiatric disease and treatment*, pp.2959-2969.

Sexton, E., McLoughlin, A., Williams, D.J., Merriman, N.A., Donnelly, N., Rohde, D., Hickey, A., Wren, M.A. and Bennett, K. (2019), 'Systematic review and meta-analysis of the prevalence of cognitive impairment no dementia in the first year post-stroke', *European stroke journal*, *4*(2), pp.160-171.

Shamshiev, A. S., Saduakas, A. Y., Zhakubaev, M. A., Matkerimov, A., Demeuov, T., Makkamov, R. O., Yerkinbayev, N., Kozhamkul, A., Appazov, D. M., Begim, N., & Davletov, D. (2024), 'Stroke: a comprehensive overview of trends, prevention, and treatment (literature review)', *Vestnik Hirurgii Kazahstana*. https://doi.org/10.35805/bsk2024iii010

Sharabiani, P.T.A., Mehdizadeh, M., Goudarzi, S., Jamali, S., Mazhar, F.N., Heidari, M., Alizadeh, N.H., Mohammadi, F., Foomani, A.S.S. and Taghizadeh, G. (2024), 'Minimal important difference of Berg Balance Scale, performance-oriented mobility assessment and dynamic gait index in chronic stroke survivors', *Journal of Stroke and Cerebrovascular Diseases*, *33*(11), p.107930.

Sharrief, A. and Grotta, J.C. (2019), 'Stroke in the elderly', *Handbook of clinical neurology*, *167*, pp.393-418.

Shin, S.S. and An, D.H. (2014), 'The effect of motor dual-task balance training on balance and gait of elderly women', *Journal of physical therapy science*, *26*(3), pp.359-361.

Silsupadol, P., Shumway-Cook, A., Lugade, V., van Donkelaar, P., Chou, L.S., Mayr, U. and Woollacott, M.H. (2009), 'Effects of single-task versus dual-task training on balance performance in older adults: a double-blind, randomized controlled trial', *Archives of physical medicine and rehabilitation*, *90*(3), pp.381-387.

Silsupadol, P., Siu, K.C., Shumway-Cook, A. and Woollacott, M.H. (2006), 'Training of balance under single-and dual-task conditions in older adults with balance impairment', *Physical therapy*, *86*(2), pp.269-281.

Sim, S.M. and Oh, D.W. (2015), 'Effect of dual-task training with cognitive motor task on walking and balance functions in patients with chronic stroke: randomized controlled pilot study', *Physical Therapy Korea*, *22*(2), pp.11-20.

Sukala, N. (2021), ‘Effect of Cognitive Dual Task Training versus Motor Dual Task Training on Balance in Post Stroke Patients’, *INTI JOURNAL*, *2021*(07).

Syed, M.J., Khatri, I.A., Alamgir, W. and Wasay, M. (2022), ‘Stroke at moderate and high altitude’, *High Altitude Medicine & Biology*, *23*(1), pp.1-7.

Ta, C. and Jin, R. (2023), June, ‘Exploring machine learning techniques for fall risk prediction using the berg balance scale’, In *2023 IEEE World AI IoT Congress (AIIoT)* (pp. 0273-0277). IEEE.

Takahashi, A., Kitsunai, S., Kawana, H., Saito, N., Yoshihara, A. and Furukawa, K. (2025), ‘Physiotherapy management focusing on proprioceptive impairment in a patient with gait and balance impairments following stroke: A case report’, *Physiotherapy Theory and Practice*, *41*(2), pp.432-446.

Trombini-Souza, F., de Moura, V.T.G., da Silva, L.W.N., dos Santos Leal, I., Nascimento, C.A., Silva, P.S.T., Perracini, M.R., Sacco, I.C., de Araújo, R.C. and de Maio Nascimento, M. (2023), ‘Effects of two different dual-task training protocols on gait, balance, and cognitive function in community-dwelling older adults: a 24-week randomized controlled trial’, *PeerJ*, *11*, p.e15030.

Valecha, J., Khalid, S., Pervez, R., Mumtaz, U., Khalid, I. and Talha, M. (2024), ‘Optimizing Motor Recovery: Dual-Task Training versus Motor Relearning Program for Ambulatory Left-Hemiplegic Stroke Patients: Dual-Task Training vs. Motor Relearning Program in Stroke’, *Allied Medical Research Journal*, *2*(2), pp.158-167.

Van Criekinge, T., Heremans, C., Burridge, J., Deutsch, J.E., Hammerbeck, U., Hollands, K., Karthikbabu, S., Mehrholz, J., Moore, J.L., Salbach, N.M. and Schröder, J. (2024), ‘Standardized measurement of balance and mobility post-stroke: Consensus-based core recommendations from the third Stroke Recovery and Rehabilitation Roundtable’, *Neurorehabilitation and neural repair*, *38*(1), pp.41-51.

Vecchio, M., Chiaramonte, R., Alessandro, D.E., Buccheri, E., Finocchiaro, P., Scaturro, D., Mauro, G.L. and Cioni, M. (2024), ‘Do proprioceptive training strategies with dual-task exercises positively influence gait parameters in chronic stroke? A systematic review’, *Journal of Rehabilitation Medicine*, *56*, p.18396.

Verghese, J., Mahoney, J., Ambrose, A.F., Wang, C. and Holtzer, R. (2010), ‘Effect of cognitive remediation on gait in sedentary seniors’, *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, *65*(12), pp.1338-1343.

Vinychuk, S.M. and Fartushna, O.Y. (2018), ‘Клінічний аналіз випадків перехресного мозочково-півкульного діашизу в пацієнтів із гострим інсультом’, *INTERNATIONAL NEUROLOGICAL JOURNAL*, (7.101), pp.12-16.

Vinychuk, S.M., Prokopiv, M.M., Trepet, L.M. and Fartushna, O.Y. (2020), ‘Клинические сосудистые синдромы таламических инсультов передней и парамедианной сосудистых территорий: проспективное клиническое когортное исследование’, *INTERNATIONAL NEUROLOGICAL JOURNAL*, *16*(2), pp.7-12.

Wang, J., Bernhardt, J., Johns, H., Churilov, L., Said, C., Fini, N.A., Batchelor, F., Collier, J., Ellery, F. and Bower, K.J. (2025), ‘An exploration of serious falls after stroke using a large international stroke rehabilitation database’, *International Journal of Stroke*, p.17474930251314330.

Wang, J., Wang, W. and Hou, Z.G. (2022), ‘EEG-based focus of attention tracking and regulation during dual-task training for neural rehabilitation of stroke patients’, *IEEE Transactions on Biomedical Engineering*, *70*(3), pp.920-930.

Wang, Q., Dai, W., Xu, S., Zhu, S., Sui, Y., Kan, C., Shen, Y., Zhu, Y., Guo, C. and Wang, T. (2023), ‘Brain activation of the PFC during dual-task walking in stroke patients: A systematic review and meta-analysis of functional near-infrared spectroscopy studies’, *Frontiers in Neuroscience*, *17*, p.1111274.

Wang, Z., Gu, A. and Lu, X. (2024), ‘Visual Quantitative Evaluation of Berg Balance Scale for Stroke Patients’, In *Electronic Engineering and Informatics* (pp. 450-457). IOS Press.

Zhang, L., Ma, J., Liu, X., Jin, A., Wang, K. and Yin, X. (2024), ‘Cognitive-motor dual-task training on gait and balance in stroke patients: meta-analytic report and trial sequential analysis of randomized clinical trials’, *Journal of NeuroEngineering and Rehabilitation*, *21*(1), p.227.

Zhang, X., Xu, F., Shi, H., Liu, R. and Wan, X. (2022), 'Effects of dual-task training on gait and balance in stroke patients: a meta-analysis', *Clinical rehabilitation*, *36*(9), pp.1186-1198

Appendix-A

Institutional Review Board (IRB) Letter

BANGLADESH HEALTH PROFESSIONS INSTITUTE

বাংলাদেশ হেলথ্ প্রফেশন্স ইনস্টিটিউট (বিএইচপিআই)
Bangladesh Health Professions Institute (BHPI)

(The Academic Institute of CRP)

Ref: CRP-BHPI/IRB/12/2024/1008

Date: 15/12/2024

To
Sabrina Tina
4th Professional Year B. Sc. in Physiotherapy
Session: 2019-2020, Student ID: 112190495
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Subject: Approval of the thesis proposal "Efficacy of cognitive dual task training on balance in patients with stroke" by ethics committee.

Dear Sabrina Tina,
Congratulations.
The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the above-mentioned dissertation, with yourself, as the principal author and Professor Dr. Md. Sohrab Hossain, Executive Director, CRP, Savar as the 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 & consent form.

The purpose of the study is to evaluate the effectiveness of cognitive dual task training on balance in patients with stroke. The study involves use of measurement tools such as Mini Mental State Examination (MMSE), Berg Balance Scale (BBS), Time up & go (TUG) and Gait parameters to identify the effectiveness of cognitive dual task training on balance in patients with stroke that may take 30 to 40 minutes to answer the questionnaire and there is no likelihood of any harm to the participants and participation in the study may benefit the participants or other stakeholders by improving targeted rehabilitation strategies to enhance balance in patients with stroke. 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 15 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 accordance to Nuremberg Code 1947, World Medical Association Declaration of Helsinki, 1964 - 2013 and other applicable regulation.

Best regards,

Muhammad Millat Hossain
Associate Professor & 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

Date: 3 October, 2024

The Chairman

Institutional Review Board (IRB)

Bangladesh Health Professions Institute (BHPI)

CRP-Savar, Dhaka – 1343, Bangladesh.

Subject: Application for review and ethical approval.

Sir,

With due respect, I would like to draw your kind attention that I am a student of B. Sc. in Physiotherapy at Bangladesh Health Professions Institute (BHPI). I would like to conduct a dissertation titled, **"Efficacy of cognitive dual task training on balance in patients with stroke"** with myself as the principle author and Professor Dr. Md. Sohrab Hossain, PhD, Executive director, CRP, Savar as my thesis supervisor. The purpose of the study is to evaluate the effectiveness of cognitive dual task training on balance in patients with stroke.

Mini mental state examination (MMSE), Berg balance scale (BBS), Time up and go (TUG), Gait parameters Questionnaire will be used in the study that will take about 30 to 40 minutes and measurements of balance and gait functions of patients with stroke. Other related information will be collected from self-structured questionnaire. Data collectors will receive informed consents from all participants. Any data collected will be kept confidential.

Therefore, I look forward to having your approval for the thesis proposal and to start data collection. I also assure you that I will maintain all the requirements for study.

Sincerely yours,

Sabrina

....

Sabrina Tina

4th Professional year B. Sc in Physiotherapy

Session: 2019-2020, Student ID: 112190495

BHPI, CRP, Savar, Dhaka- 1343, Bangladesh

Recommendation from the thesis supervisor:

....

Professor Dr. Md. Sohrab Hossain, PhD

Executive Director

CRP, Savar, Dhaka-1343, Bangladesh

Appendix-B

Data Collection Permission Letter

31st December, 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 research project.

Sir,

With due to respect and humble submission to state that I am Sabrina Tina, a student of 4th year B.Sc. in physiotherapy at Bangladesh Health Professions Institute (BHPI). The Ethical committee has approved my research project entitled: **"Efficacy of cognitive dual task training on balance in patients with stroke"** under the supervision ofProfessor Dr. Md. Sohrab Hossain, PhD, Executive director, CRP, Savar. 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 of Physiotherapy Department at CRP-Savar, Dhaka-1343. I would like to assure that anything of the study will not be harmful for 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,

Sabrina Tina Sabrina

4th Year B.Sc. in Physiotherapy

Class Roll: 01; Session: 2019-20

Bangladesh Health Professions Institute (BHPI)

(An academic Institution of CRP)

CRP-Chapain, Savar, Dhaka-1343.

Forwarded and Recommended

31/12/2024.

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

Dept of physiotherapy may please co-operate to this student for collecting data.

Approved.

2/1/25

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

Appendix-C

Conventional Physiotherapy Treatment Protocol

Assalamualaikum/Adab,

I am Sabrina Tina, student of 4th Professional B. Sc. in Physiotherapy program at Bangladesh Health Professions Institute (BHPI). For my study purpose I am conducting a study on stroke patients and my study title is **"Efficacy of cognitive dual task training on balance in patients with stroke."**

For my research purpose, I need the expert's opinions. So, I humbly request that you provide me the conventional balance exercise regimen.

Research objectives: To evaluate the efficacy of cognitive dual task training on balance in patients with stroke.

Conventional physiotherapy treatment for balance:

- Static & dynamic standing c̄ modified BOS
- Stepping
- Single leg stance
- Reaching
- Control wt. bearing
- Reactive balance ex.
- Squatting practice
- Ball throwing practice
- Gait practice on different surfaces.
- ……………………………………………………

25/9/24

Assalamualaikum/Adab,

I am Sabrina Tina, student of 4th Professional B. Sc. in Physiotherapy program at Bangladesh Health Professions Institute (BHPI). For my study purpose I am conducting a study on stroke patients and my study title is **"Efficacy of cognitive dual task training on balance in patients with stroke."**

For my research purpose, I need the expert's opinions. So, I humbly request that you provide me the conventional balance exercise regimen.

Research objectives: To evaluate the efficacy of cognitive dual task training on balance in patients with stroke.

Conventional physiotherapy treatment for balance:

- Postural Correction.
- trunk and pelvic Control ex.
- sitting and standing practice
- Reaching.
- Ball throwing.
- wobble board balance training.
- Proprioception training (soft surface training)
- Controlled weight Shifting.
- Physio ball activity
- Frankle exercise.

25.3.24

Assalamualaikum/Adab,

I am Sabrina Tina, student of 4th Professional B. Sc. in Physiotherapy program at Bangladesh Health Professions Institute (BHPI). For my study purpose I am conducting a study on stroke patients and my study title is **"Efficacy of cognitive dual task training on balance in patients with stroke."**

For my research purpose, I need the expert's opinions. So, I humbly request that you provide me the conventional balance exercise regimen.

Research objectives: To evaluate the efficacy of cognitive dual task training on balance in patients with stroke.

Conventional physiotherapy treatment for balance:

- Sitting dynamic
- " Static
- Reaching practice ē colourful toys
- Double leg bridging /single leg
- High Kneeling
- Pelvic control ex. on physioball
- Balance board ex.
- " ē ball throwing
- ~~Abdu~~ Practice on abducton leather
- Practice on foot print

Backward, lateral walking
Single line walking
Stairing
Trampoline practice

(1402)
25.9.24.

Informed Consent

Verbal Consent Form

(Please read out to the participants)

Assalamualaikum / Greetings,

I am **Sabrina Tina**, a final year B. Sc in Physiotherapy student of Bangladesh Health Professions Institute under the Medicine faculty of the University of Dhaka. To obtain my Bachelor's degree, I shall have to conduct research, which is a part of my study. The participants are requested to participate in the study after reading the following.

My research title is **"Efficacy of cognitive dual-task training on balance in patients with stroke"**. The purpose of this study is to investigate whether combining cognitive exercises with conventional balance exercises can improve balance in patients who have experienced a stroke. If this study is successful, the findings may provide important insights into the rehabilitation process for stroke patients.

To implement my research project, I need to collect data from the patients. Therefore, you could be one of my valuable subjects for my study. Participation in this research will involve answering some questions, which are mentioned in the attached form. This will take approximately 30 to 40 minutes.

I am committed that the study will not pose any harm or risk to you. You have the absolute right to withdraw or discontinue at any time without any hesitation or risk. I will keep all the information confidential that I obtained from you, and the personal identification of the participant will not be published anywhere. If you have any queries about the study, you may contact the researcher, **Sabrina Tina**, or the supervisor, **Professor Dr. Md. Sohrab Hossain, PhD**, Executive Director, CRP, Savar, Dhaka-1343.

Do you have any questions before I start?

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

Yes ☐ No ☐

Signature of the participant & Date……………………………

Signature of the researcher & Date……………………………..

মৌখিক সম্মতি ফর্ম

(অনুগ্রহ করে অংশগ্রহণকারীদের উদ্দেশ্যে এটি পড়ে শোনাবেন)

আসসালামু আলাইকুম\ নমস্কার,

আমি **সাবরিনা টিনা**, ঢাকা বিশ্ববিদ্যালয়ের মেডিসিন অনুষদের অধীনে বাংলাদেশ হেলথ প্রফেশনস ইনস্টিটিউটের একজন চূড়ান্ত বর্ষের ফিজিওথেরাপি (বি.এসসি) শিক্ষার্থী। আমার স্নাতক ডিগ্রি অর্জনের জন্য একটি গবেষণা পরিচালনা করতে হবে, যা আমার পড়াশোনার একটি অংশ। নিচের তথ্য পড়ে আপনি যদি রাজি থাকেন, তাহলে এই গবেষণায় অংশগ্রহণের জন্য অনুরোধ করছি।

আমার গবেষণার শিরোনাম হলো: **"স্ট্রোকে আক্রান্ত রোগীদের ভারসাম্য উন্নয়নে কগনিটিভ ডুয়াল টাস্ক ট্রেইনিং এর কার্যকারিতা।"** এই গবেষণার উদ্দেশ্য হলো দেখানো যে, মানসিক অনুশীলন ও প্রচলিত ব্যালেন্স অনুশীলনের সমন্বয় স্ট্রোকে আক্রান্ত রোগীদের ভারসাম্য উন্নয়নে সহায়ক কি না। যদি গবেষণাটি সফল হয়, তাহলে এটি স্ট্রোক রোগীদের পুনর্বাসন প্রক্রিয়া সম্পর্কে গুরুত্বপূর্ণ তথ্য প্রদান করতে পারে।

এই গবেষণা বাস্তবায়নের জন্য আমাকে রোগীদের কাছ থেকে কিছু তথ্য সংগ্রহ করতে হবে। আপনি আমার এই গবেষণার একজন গুরুত্বপূর্ণ অংশগ্রহণকারী হতে পারেন। এই গবেষণায় অংশগ্রহণের ক্ষেত্রে আপনাকে কিছু প্রশ্নের উত্তর দিতে হবে, যা সংযুক্ত ফর্মে উল্লেখ করা আছে। এতে আনুমানিক ৩০ থেকে ৪০ মিনিট সময় লাগবে।

আমি নিশ্চিত করছি যে, এই গবেষণার মাধ্যমে আপনার কোনো ক্ষতি বা ঝুঁকি হবে না। আপনি যেকোনো সময় কোনো দ্বিধা বা ঝুঁকি ছাড়াই অংশগ্রহণ প্রত্যাহার বা বন্ধ করতে পারেন। আপনি যে সকল তথ্য দিবেন তা সম্পূর্ণ গোপন রাখা হবে এবং আপনার ব্যক্তিগত পরিচয় কোথাও প্রকাশ করা হবে না।

যদি গবেষণা সম্পর্কে আপনার কোনো প্রশ্ন থাকে, তাহলে আপনি গবেষক **সাবরিনা টিনা** অথবা উনার তত্ত্বাবধায়ক **প্রফেসর ড. মো. সোহরাব হোসেন, পিএইচডি,** নির্বাহী পরিচালক, সিআরপি, সাভার, ঢাকা-১৩৪৩ এর সাথে যোগাযোগ করতে পারেন।

গবেষণা শুরু করার আগে আপনার কোনো প্রশ্ন আছে কি?

তাহলে, আমি কি আপনার সম্মতি পেতে পারি সাক্ষাৎকার গ্রহণ করার জন্য?

হ্যাঁ □ না □

অংশগ্রহণকারীর স্বাক্ষর ও তারিখ: ....

গবেষকের স্বাক্ষর ও তারিখ: ....

Questionnaire (English)

This questionnaire is developed for the assessment of balance and gait of patient with stroke and please use a black pen to fill up the answer. Each question should be answer by tick (√) marking.

Patient ID: Date of interview:

Part – 1: Patient's Information

Serial No	Question	Response
1	Patient name	
2	Age	………………… ………Years
3	Gender	☐ Male ☐ Female
4	Contact number	
5	Living area	☐ Rural ☐ Urban ☐ Semi urban
6	Marital status	☐ Married ☐ Unmarried ☐ Widow ☐ Divorced
7	Level of education	☐ No formal education ☐ Primary ☐ SSC ☐ HSC ☐ Graduate/ Post graduate

8	What is your family type?	☐ Nuclear ☐ Joint
9	What is your occupation?	☐ Business ☐ Service holder ☐ Government job ☐ Private job ☐ Others
9	What are your average monthly household expenses?	

Part – 2: Physical parameter

Serial No	Categories	Response
1.	Weight	
2.	Height	
3.	BMI	

Part – 3: Stroke-related information

Serial No	Categories	Response
1.	Date of incidence of stroke	
2.	Which type of stroke did you have?	☐ Ischemic ☐ Hemorrhagic

3.	Which side hemiplegia do you have?	☐ Right ☐ Left ☐ Bilateral
4.	Number of strokes	☐ First ☐ Second ☐ Multiple
5.	Family history of stroke	☐ Yes ☐ No
6.	Number of using aids	☐ No aid ☐ Cane ☐ Walker ☐ Others

Pretest

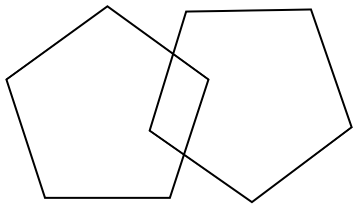
Patient Name: Date of pre-test:

Part – 4: Assessment of cognitive function by Mini Mental State Examination

The Mini Mental State Examination (MMSE) is a tool that can be used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment. The MMSE takes only 5-10 minutes to administer and is therefore practical to use repeatedly and routinely.

(Lenore Kurlowicz et al., 1999)

Question	Patient score	Maximum score
What is the year? Month? Season? Date? Day of the week?		5
Where are we now? State? Country? Town/City? Hospital? Floor?		5
I will name 3 objects (pen, chair, Book). Now repeat the 3 objects. (Score 1 mark for each correct answer, now repeat the 3 objects name until the patients learns all of them)		3
What is the day before Friday? Day before that? Day before that? Day before that? Day before that?		5
"Earlier I told you the names of 3 things. Can you tell me what those were?		3
(Showing wristwatch) name this object, (Showing Pencil) name this object		2
Listen carefully what I say and then repeat them, "One shallow does not make summer"		1
Follow my instructions "Take the paper in your right hand, then fold it in half and give me it on my hand"		3

Follow my instructions do what I do, “Close your eye for 2 seconds”.		1
Say one line about what you see around you		1
Please copy next to the picture below 		1
Total		30

Part – 5: Assessment of balance by Berg Balance Scale

The BBS is a 14-item scale that quantitatively assesses balance. The items are scored from 0 to 4, with a score of 0 representing an inability to complete the task and a score o=f 4 representing independent item achievement. A global score is calculated out of 56 possible points. This section of questionnaire will be filled by the physiotherapist using a pencil.

(Tick ✔ the point, which is able to perform patient)

Question	Instructions	Response
5.1. Sitting to standing	Please stand up. Try not to use your hand for support	☐ **4** able to stand without using hands and stabilize independently ☐ **3** able to stand independently using hands ☐ **2** able to stand using hands after several tries ☐ **1** needs minimal aid to stand or stabilize ☐ **0** needs moderate or maximal assist to stand
5.2. Standing unsupported	Please stand for two minutes without holding on	☐ **4** able to stand safely for 2 minutes ☐ **3** able to stand 2 minutes with supervision ☐ **2** able to stand 30 seconds unsupported ☐ **1** needs several tries to stand 30 seconds unsupported ☐ **0** unable to stand 30 seconds unsupported
5.3. Sitting with back unsupported	Please sit with arms folded for 2 minutes	☐ **4** able to sit safely and securely for 2 minutes

but feet supported on floor or on a tool		☐ **3** able to sit 2 minutes under supervision ☐ **2** able to sit 30 seconds ☐ **1** able to sit 10 seconds ☐ **0** unable to sit without support 10 seconds
5.4. Standing to sitting	Please sit down	☐ **4** sits safely with minimal use of hands ☐ **3** controls descent by using hands ☐ **2** uses back of legs against chair to control descent ☐ **1** sits independently but has uncontrolled descent ☐ **0** needs assist to sit
5.5. Transfer	Arrange chair for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use a bed and a chair	☐ **4** able to transfer safely with minor use of hands ☐ **3** able to transfer safely definite need of hand ☐ **2** able to transfer with verbal cuing and/or supervision ☐ **1** needs one person to assist ☐ **0** needs two people to assist or supervise to be safe
5.6. Standing unsupported with eye closed	Please close your eyes and stand still for 10 seconds	☐ **4** able to stand 10 seconds safely ☐ **3** able to stand 10 seconds with supervision ☐ **2** able to stand 3 seconds

		☐ **1** unable to keep eyes closed 3 seconds but stays safely ☐ **0** needs help to keep from falling
5.7. Standing unsupported with feet together	Place your feet together and stand without holding on	☐ **4** able to place feet together independently and stand 1 minute safely ☐ **3** able to place feet together independently and stand 1 minute with supervision ☐ **2** able to place feet together independently but unable to hold for 30 seconds ☐ **1** needs help to attain position but able to stand 15 seconds feet together ☐ **0** needs help to attain position and unable to hold for 15 seconds
5.8. Reaching forward with outstretched arm while standing	Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Ask subject to use both arms when reaching to avoid rotation of the trunk)	☐ **4** can reach forward confidently 25 cm (10 inches) ☐ **3** can reach forward 12 cm (5 inches) ☐ **2** can reach forward 5 cm (2 inches) ☐ **1** reaches forward but needs supervision ☐ **0** loses balance while trying/ requires external support
5.9. Pick up object from the floor from a standing position	Pick up the shoe/slipper, which is place in front of your feet	☐ **4** able to pick up slipper safely and easily

		☐ **3** able to pick up slipper but needs supervision ☐ **2** unable to pick up but reaches 2-5 cm from slipper and keeps balance Independently ☐ **1** unable to pick up and needs supervision while trying ☐ **0** unable to try/needs assist to keep from losing balance or falling
5.10. Turning to look behind over left and right shoulder while standing	Turn to look directly behind you over toward the left shoulder. Repeat to the right. Examiner may pick an object to look at directly behind the subject to encourage a better twist turn	☐ **4** looks behind from both sides and weight shifts well ☐ **3** looks behind one side only other side shows less weight shift ☐ **2** turns sideways only but maintains balance ☐ **1** needs supervision when turning ☐ **0** needs assist to keep from losing balance or falling
5.11. Turn 360 degrees	Turn completely around in a full circle. Pause. Then turn a full circle in the other direction	☐ **4** able to turn 360 degrees safely in 4 seconds or less ☐ **3** able to turn 360 degrees safely one side only 4 seconds or less ☐ **2** able to turn 360 degrees safely but slowly

		☐ **1** needs close supervision or verbal cuing ☐ **0** needs assistance while turning
5.12. Place alternate foot on step or tool while standing unsupported	Place each foot alternately on the step/stool. Continue until each foot has touch the step/stool four times	☐ **4** able to stand independently and safely and complete 8 steps in 20 seconds ☐ **3** able to stand independently and complete 8 steps in > 20 seconds ☐ **2** able to complete 4 steps without aid with supervision ☐ **1** able to complete > 2 steps needs minimal assist ☐ **0** needs assistance to keep from falling/unable to try
5.13. Standing unsupported one foot in front	Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width.)	☐ **4** able to place foot tandem independently and hold 30 seconds ☐ **3** able to place foot ahead independently and hold 30 seconds ☐ **2** able to take small step independently and hold 30 seconds ☐ **1** needs help to step but can hold 15 seconds ☐ **0** loses balance while stepping or standing

2.14. Standing on one leg	Stand on one leg as long as you can without holding on	☐ **4** able to lift leg independently and hold > 10 seconds ☐ **3** able to lift leg independently and hold 5-10 seconds ☐ **2** able to lift leg independently and hold ≥ 3 seconds ☐ **1** tries to lift leg unable to hold 3 seconds but remains standing independently ☐ **0** unable to try of needs assist to prevent fall
Total Score		

<u>Interpretation:</u>

Highest possible score: 56

- 41-56: Low fall risk
- 21-40: Medium fall risk
- 0-20: High fall risk

Part – 6: Assessment of Gait

Time Up and Go test (TUG)

General instruction:

Purpose – To assess mobility

Equipment – Stopwatch

Direction – Patient wears their regular footwear and can use a walking aid, if needed. Begin by having the patient sit back in a standard and identify a line 3 meters, or 10 feet away on the floor.

1. Instruct the patient

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

- Stand up from the chair.
- Walk to the line on the floor at your normal pace.
- Turn.
- Walk back to the chair at your normal pace.
- Sit down again.

2. On the word "Go," begin timing.
3. Stop timing after patient sits back down.
4. Record Time

An adult who takes ≥ 12 seconds to complete the TUG is at risk for falling.

Time up & go test (TUG) (second)	Time taken by stopwatch

Gait Parameter Scale

Measurement of Step Length

Distance from sound heel print to affected heel print = Step Length

Gait parameter	Pre test	Post test
Step Length		

Measurement of Stride Length

Total step = Total distance =

Gait parameter	Pre test	Post test
Stride Length		

Measurement of speed

Distance/Time = Speed

Distance = Time =

Gait parameter	Pre test	Post test
Gait speed		

Measurement of Cadence

Number of steps in 1 minute = Cadence

Gait parameter	Pre test	Post test
Cadence		

Post-test

Date of post-test:

Part – 5: Assessment of balance by Berg Balance Scale

The BBS is a 14-item scale that quantitatively assesses balance. The items are scored from 0 to 4, with a score of 0 representing an inability to complete the task and a score of 4 representing independent item achievement. A global score is calculated out of 56 possible points. This section of the questionnaire will be filled in by the physiotherapist using a pencil.

(Tick ✓ the point, which is able to perform patient)

Question	Instructions	Response
5.1. Sitting to standing	Please stand up. Try not to use your hand for support	☐ **4** able to stand without using hands and stabilize independently ☐ **3** able to stand independently using hands ☐ **2** able to stand using hands after several tries ☐ **1** needs minimal aid to stand or stabilize ☐ **0** needs moderate or maximal assist to stand
5.2. Standing unsupported	Please stand for two minutes without holding on	☐ **4** able to stand safely for 2 minutes

		☐ **3** able to stand 2 minutes with supervision ☐ **2** able to stand 30 seconds unsupported ☐ **1** needs several tries to stand 30 seconds unsupported ☐ **0** unable to stand 30 seconds unsupported
5.3. Sitting with back unsupported but feet supported on floor or on a tool	Please sit with arms folded for 2 minutes	☐ **4** able to sit safely and securely for 2 minutes ☐ **3** able to sit 2 minutes under supervision ☐ **2** able to sit 30 seconds ☐ **1** able to sit 10 seconds ☐ **0** unable to sit without support 10 seconds
5.4. Standing to sitting	Please sit down	☐ **4** sits safely with minimal use of hands ☐ **3** controls descent by using hands ☐ **2** uses back of legs against chair to control descent ☐ **1** sits independently but has uncontrolled descent ☐ **0** needs assist to sit
5.5. Transfer	Arrange chair for pivot transfer. Ask subject to transfer one way toward	☐ **4** able to transfer safely with minor use of hands

	a seat with armrests and one way toward a seat without armrests. You may use a bed and a chair	☐ **3** able to transfer safely definite need of hand ☐ **2** able to transfer with verbal cuing and/or supervision ☐ **1** needs one person to assist ☐ **0** needs two people to assist or supervise to be safe
5.6. Standing unsupported with eye closed	Please close your eyes and stand still for 10 seconds	☐ **4** able to stand 10 seconds safely ☐ **3** able to stand 10 seconds with supervision ☐ **2** able to stand 3 seconds ☐ **1** unable to keep eyes closed 3 seconds but stays safely ☐ **0** needs help to keep from falling
5.7. Standing unsupported with feet together	Place your feet together and stand without holding on	☐ **4** able to place feet together independently and stand 1 minute safely ☐ **3** able to place feet together independently and stand 1 minute with supervision ☐ **2** able to place feet together independently but unable to hold for 30 seconds ☐ **1** needs help to attain position but able to stand 15 seconds feet together ☐ **0** needs help to attain position and unable to hold for 15 seconds
5.8. Reaching forward with	Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as	☐ **4** can reach forward confidently 25 cm (10 inches)

outstretched arm while standing	you can. (Ask subject to use both arms when reaching to avoid rotation of the trunk)	☐ **3** can reach forward 12 cm (5 inches) ☐ **2** can reach forward 5 cm (2 inches) ☐ **1** reaches forward but needs supervision ☐ **0** loses balance while trying/ requires external support
5.9. Pick up object from the floor from a standing position	Pick up the shoe/slipper, which is place in front of your feet	☐ **4** able to pick up slipper safely and easily ☐ **3** able to pick up slipper but needs supervision ☐ **2** unable to pick up but reaches 2-5 cm from slipper and keeps balance Independently ☐ **1** unable to pick up and needs supervision while trying ☐ **0** unable to try/needs assist to keep from losing balance or falling
2.10. Turning to look behind over left and right shoulder while standing	Turn to look directly behind you over toward the left shoulder. Repeat to the right. Examiner may pick an object to look at directly behind the subject to encourage a better twist turn	☐ **4** looks behind from both sides and weight shifts well ☐ **3** looks behind one side only other side shows less weight shift ☐ **2** turns sideways only but maintains balance ☐ **1** needs supervision when turning

		☐ **0** needs assist to keep from losing balance or falling
5.11. Turn 360 degrees	Turn completely around in a full circle. Pause. Then turn a full circle in the other direction	☐ **4** able to turn 360 degrees safely in 4 seconds or less ☐ **3** able to turn 360 degrees safely one side only 4 seconds or less ☐ **2** able to turn 360 degrees safely but slowly ☐ **1** needs close supervision or verbal cuing ☐ **0** needs assistance while turning
5.12. Place alternate foot on step or tool while standing unsupported	Place each foot alternately on the step/stool. Continue until each foot has touch the step/stool four times	☐ **4** able to stand independently and safely and complete 8 steps in 20 seconds ☐ **3** able to stand independently and complete 8 steps in > 20 seconds ☐ **2** able to complete 4 steps without aid with supervision ☐ **1** able to complete > 2 steps needs minimal assist ☐ **0** needs assistance to keep from falling/unable to try
5.13. Standing unsupported one foot in front	Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of	☐ **4** able to place foot tandem independently and hold 30 seconds

	the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width.)	☐ **3** able to place foot ahead independently and hold 30 seconds ☐ **2** able to take small step independently and hold 30 seconds ☐ **1** needs help to step but can hold 15 seconds ☐ **0** loses balance while stepping or standing
2.14. Standing on one leg	Stand on one leg as long as you can without holding on	☐ **4** able to lift leg independently and hold > 10 seconds ☐ **3** able to lift leg independently and hold 5-10 seconds ☐ **2** able to lift leg independently and hold ≥ 3 seconds ☐ **1** tries to lift leg unable to hold 3 seconds but remains standing independently ☐ **0** unable to try of needs assist to prevent fall
Total Score		

Part – 6: Assessment of Gait

Time Up and Go test (TUG):

General instruction:

Purpose – To assess mobility

Equipment – Stopwatch

Direction – Patient wears their regular footwear and can use a walking aid, if needed. Begin by having the patient sit back in a standard and identify a line 3 meters, or 10 feet away on the floor.

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- Turn.
- Walk back to the chair at your normal pace.
- Sit down again.

2. On the word "Go," begin timing.
3. Stop timing after patient sits back down.
4. Record Time

An adult who takes ≥ 12 seconds to complete the TUG is at risk for falling.

Time up & go test (TUG) (second)	Time taken by stopwatch

প্রশ্নাবলী (বাংলা)

এই প্রশ্নাবলীটি স্ট্রোকে আক্রান্ত রোগীদের ভারসাম্য এবং হাঁটার ক্ষমতা মূল্যায়নের জন্য তৈরি করা হয়েছে। অনুগ্রহ করে কালো কালি কলম ব্যবহার করে উত্তর প্রদান করুন। প্রতিটি প্রশ্নের উত্তরের ঘরে (√) চিহ্ন দিন।

রোগীর আইডি: ....

সাক্ষাৎকার গ্রহণের তারিখ: ....

অংশ – ১: রোগীর তথ্য

ক্রমিক নং	প্রশ্ন	উত্তর
১	রোগীর নাম	
২	বয়স	.... বছর
৩	লিঙ্গ	☐ পুরুষ ☐ মহিলা
৪	যোগাযোগ নম্বর	
৫	বসবাসের এলাকা	☐ গ্রামীণ ☐ শহর ☐ আধা-শহর
৬	বৈবাহিক অবস্থা	☐ বিবাহিত ☐ অবিবাহিত ☐ বিধবা ☐ তালাকপ্রাপ্ত
৭	শিক্ষাগত যোগ্যতা	☐ কোনো প্রাতিষ্ঠানিক শিক্ষা নেই ☐ প্রাথমিক ☐ এসএসসি ☐ এইচএসসি ☐ স্নাতক/স্নাতকোত্তর

৮	আপনার পরিবারিক ধরন কী?	☐ একক পরিবার ☐ যৌথ পরিবার
৯	আপনার পেশা কী?	☐ ব্যবসা ☐ চাকরিজীবী ☐ সরকারি চাকরি ☐ বেসরকারি চাকরি ☐ অন্যান্য
১০	আপনার পরিবারের গড় মাসিক খরচ কত?	

অংশ – ২: শারীরিক পরামিতি

ক্রমিক নং	**বিভাগ**	**উত্তর**
১	ওজন	
২	উচ্চতা	
৩	বিএমআই (BMI)	

অংশ – ৩: স্ট্রোক সম্পর্কিত তথ্য

ক্রমিক নং	বিভাগ	উত্তর
১	স্ট্রোক হওয়ার তারিখ	
২	আপনি কোন ধরণের স্ট্রোকে আক্রান্ত হয়েছেন?	☐ ইস্কেমিক ☐ হেমোরেজিক
৩	আপনার শরীরের কোন পাশে পক্ষাঘাত হয়েছে?	☐ ডান ☐ বাম ☐ উভয় পাশে
৪	আপনি কতবার স্ট্রোকে আক্রান্ত হয়েছেন?	☐ প্রথমবার ☐ দ্বিতীয়বার ☐ একাধিকবার
৫	পরিবারের কারো স্ট্রোকের ইতিহাস আছে কি?	☐ হ্যাঁ ☐ না
৬	সাহায্যকারী যন্ত্র ব্যবহার	☐ কোনো যন্ত্র ব্যবহার করি না ☐ ছড়ি (Cane) ☐ ওয়াকার (Walker) ☐ অন্যান্য

পূর্বপরীক্ষা (Pretest)

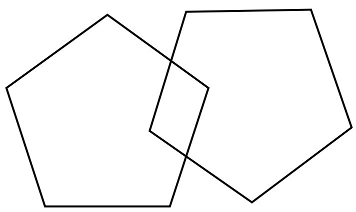
রোগীর নাম: পূর্বপরীক্ষারতারিখ:

<u>অংশ - ৪: মিনি মেন্টাল স্টেট এক্সামিনেশন (MMSE) দ্বারা মানসিক দক্ষতা মূল্যায়ন</u>

Mini Mental State Examination (MMSE) একটি মানসিক অবস্থা পরিমাপের টুল যা সুসংগঠিত ও পুঙ্খানুপুঙ্খভাবে মানসিক সক্ষমতা মূল্যায়নের জন্য ব্যবহৃত হয়। এতে মোট ১১টি প্রশ্ন থাকে এবং এটি পাঁচটি কগনিটিভ ফাংশন মূল্যায়ন করে — স্থানজ্ঞান, নিবন্ধন, মনোযোগ ও গণনা, স্মরণশক্তি, এবং ভাষা। সর্বোচ্চ স্কোর ৩০, এবং ২৩ বা এর কম স্কোর মানসিক দুর্বলতা নির্দেশ করে। এই টেস্ট সম্পন্ন করতে মাত্র ৫-১০ মিনিট সময় লাগে এবং এটি পুনরাবৃত্তিমূলকভাবে ব্যবহার করা যায়।

(Lenore Kurlowicz et al., 1999)

প্রশ্ন	রোগীর স্কোর	সর্বোচ্চ স্কোর
বছর, মাস, ঋতু, তারিখ, সপ্তাহের দিন কত?		৫
এখন আমরা কোথায় আছি? জেলা, দেশ, শহর/গ্রাম, হাসপাতাল, তলা		৫
আমি তিনটি বস্তু বলব (কলম, চেয়ার, বই)। দয়া করে পুনরাবৃত্তি করুন। (প্রতিটি সঠিক উত্তরের জন্য ১ নম্বর দিন)		৩
শুক্রবারের আগের দিন? তার আগের দিন? তার আগের দিন? তার আগের দিন? তার আগের দিন?		৫
আগেই বলা তিনটি বস্তুর নাম আবার বলুন		৩
(ঘড়ি দেখিয়ে) এই বস্তুটির নাম বলুন, (পেন্সিল দেখিয়ে) এই বস্তুটির নাম বলুন		২

মনোযোগ দিয়ে শুনুন এবং পুনরাবৃত্তি করুন: “One shallow does not make summer”		১
আমার নির্দেশনা অনুসরণ করুন: “আপনার ডান হাতে কাগজটি নিন, অর্ধেক ভাঁজ করুন এবং আমার হাতে দিন।”		৩
আমি যা করছি, তাই করুন: “২ সেকেন্ডের জন্য চোখ বন্ধ করুন।		১
আপনার চারপাশে যা দেখছেন তা নিয়ে একটি বাক্য বলুন		১
নিচের ছবিটির অনুকরণে আঁকুন 		১
মোট স্কোর		৩০

অংশ - ৫: বার্গ ব্যালেন্স স্কেল (BBS) দ্বারা ভারসাম্য মূল্যায়ন

Berg Balance Scale (BBS) একটি ১৪-আইটেম বিশিষ্ট স্কেল যা পরিমাণগতভাবে ভারসাম্য মূল্যায়ন করে। প্রতিটি আইটেম ০ থেকে ৪ স্কোরে মূল্যায়ন করা হয়, যেখানে ০ মানে কাজটি সম্পূর্ণ করতে অক্ষম এবং ৪ মানে কাজটি স্বাধীনভাবে সম্পন্ন করতে সক্ষম। সর্বোচ্চ স্কোর ৫৬। এই অংশটি একজন ফিজিওথেরাপিস্ট পেন্সিল ব্যবহার করে পূরণ করবেন।

যে পয়েন্টটি রোগী সম্পাদন করতে সক্ষম, তা টিক ✓ চিহ্ন দিন)

প্রশ্ন	নির্দেশনা	প্রতিক্রিয়া
৫.১. বসা থেকে দাঁড়ানো	দয়া করে উঠে দাঁড়ান। হাত ব্যবহার না করার চেষ্টা করুন।	☐ ৪ – হাত ব্যবহার না করেই স্বাধীনভাবে দাঁড়াতে পারে ☐ ৩ – হাত ব্যবহার করে স্বাধীনভাবে দাঁড়াতে পারে ☐ ২ – কয়েকবার চেষ্টার পরে হাত ব্যবহার করে দাঁড়াতে পারে ☐ ১ – সামান্য সাহায্যে দাঁড়াতে পারে ☐ ০ – মাঝারি বা অতিরিক্ত সাহায্য ছাড়া দাঁড়াতে পারে না
৫.২. সমর্থন ছাড়া দাঁড়িয়ে থাকা	দয়া করে দুই মিনিট দাঁড়িয়ে থাকুন, কিছু না ধরে	☐ ৪ – নিরাপদে ২ মিনিট দাঁড়াতে পারে ☐ ৩ – তত্ত্বাবধানে ২ মিনিট দাঁড়াতে পারে ☐ ২ – সমর্থন ছাড়াই ৩০ সেকেন্ড দাঁড়াতে পারে

		☐ ১ – কয়েকবার চেষ্টা করে ৩০ সেকেন্ড দাঁড়াতে পারে ☐ ০ – ৩০ সেকেন্ড দাঁড়াতে অক্ষম
৫.৩. পায়ের নিচে মেঝে বা একটি স্টলে সহায়তা থাকা অবস্থায়, পিঠের পেছনে কোনো ভর বা সমর্থন ছাড়া বসা	দয়া করে দুই মিনিট হাত ভাঁজ করে বসে থাকুন	☐ ৪ – নিরাপদে ও নিশ্চিতভাবে ২ মিনিট বসে থাকতে পারে ☐ ৩ – তত্ত্বাবধানে ২ মিনিট বসতে পারে ☐ ২ – ৩০ সেকেন্ড বসতে পারে ☐ ১ – ১০ সেকেন্ড বসতে পারে ☐ ০ – ১০ সেকেন্ড বসতে পারে না
৫.৪. দাঁড়ানো থেকে বসা	দয়া করে বসে পড়ুন	☐ ৪ – খুব কম সহায়তায় নিরাপদে বসে পড়ে ☐ ৩ – হাত ব্যবহার করে নিয়ন্ত্রিতভাবে বসে পড়ে ☐ ২ – চেয়ারের পেছনে পা ঠেকিয়ে নিয়ন্ত্রণ করে বসে পড়ে ☐ ১ – স্বাধীনভাবে বসে পড়ে তবে নিয়ন্ত্রণহীনভাবে ☐ ০ – বসতে সাহায্যের প্রয়োজন
৫.৫. স্থানান্তর	একদিকে হাতলসহ এবং অন্যদিকে হাতলবিহীন চেয়ারে স্থানান্তর করতে বলুন	☐ ৪ – সামান্য হাত ব্যবহার করে নিরাপদে স্থানান্তর করতে পারে

		☐ ৩ – হাতের ব্যবহার স্পষ্টভাবে দরকার হয় ☐ ২ – মৌখিক সহায়তা বা তত্ত্বাবধানে স্থানান্তর করতে পারে ☐ ১ – একজন ব্যক্তির সাহায্যে স্থানান্তর করতে পারে ☐ ০ – দু'জনের সহায়তা দরকার
৫.৬. চোখ বন্ধ করে দাঁড়িয়ে থাকা	দয়া করে চোখ বন্ধ করে ১০ সেকেন্ড স্থিরভাবে দাঁড়িয়ে থাকুন	☐ ৪ – নিরাপদে ১০ সেকেন্ড দাঁড়াতে পারে ☐ ৩ – তত্ত্বাবধানে দাঁড়াতে পারে ☐ ২ – ৩ সেকেন্ড দাঁড়াতে পারে ☐ ১ – চোখ বন্ধ রাখতে পারে না তবে নিরাপদে দাঁড়িয়ে থাকে ☐ ০ – পড়ে যাওয়ার ঝুঁকি থাকায় সাহায্য প্রয়োজন
৫.৭. একসাথে পা রেখে দাঁড়িয়ে থাকা	পা দুটি একসাথে রেখে দাঁড়ান এবং কিছু না ধরে থাকুন	☐ ৪ – স্বাধীনভাবে এক মিনিট নিরাপদে দাঁড়াতে পারে ☐ ৩ – তত্ত্বাবধানে এক মিনিট দাঁড়াতে পারে ☐ ২ – স্বাধীনভাবে দাঁড়াতে পারে তবে ৩০ সেকেন্ড ধরে রাখতে পারে না ☐ ১ – অবস্থানে সহায়তা লাগলেও ১৫ সেকেন্ড দাঁড়াতে পারে

		☐ ০ – অবস্থানে সহায়তা লাগলেও ১৫ সেকেন্ড দাঁড়াতে পারে না
৫.৮. হাত সামনে বাড়িয়ে দাঁড়িয়ে থাকা	৯০ ডিগ্রিতে হাত তুলে সামনে যতদূর পারেন বাড়িয়ে দিন	☐ ৪ – আত্মবিশ্বাসের সঙ্গে ২৫ সেমি পর্যন্ত পৌঁছাতে পারে ☐ ৩ – ১২ সেমি পর্যন্ত পৌঁছাতে পারে ☐ ২ – ৫ সেমি পর্যন্ত পৌঁছাতে পারে ☐ ১ – পৌঁছাতে পারে তবে তত্ত্বাবধান প্রয়োজন ☐ ০ – ভারসাম্য হারায় বা বাহ্যিক সহায়তা দরকার
৫.৯. নিচ থেকে বস্তু তোলা (দাঁড়িয়ে)	আপনার পায়ের সামনে রাখা স্লিপার তুলুন	☐ ৪ – নিরাপদে সহজেই তুলতে পারে ☐ ৩ – তুলতে পারে তবে তত্ত্বাবধান প্রয়োজন ☐ ২ – তুলতে পারে না তবে ২-৫ সেমি পর্যন্ত পৌঁছে ভারসাম্য বজায় রাখতে পারে ☐ ১ – তুলতে পারে না, চেষ্টা করলে তত্ত্বাবধান প্রয়োজন ☐ ০ – চেষ্টা করতে পারে না / ভারসাম্য রাখতে সহায়তা দরকার

৫.১০. দাঁড়িয়ে থাকা অবস্থায় বাম ও ডান কাঁধের ওপর দিয়ে পিছনে তাকানো	আগে বাম কাঁধের ওপর দিয়ে পুরোপুরি পিছনে তাকান, তারপর ডান কাঁধ দিয়ে। প্রয়োজনে লক্ষ্য করার জন্য পেছনে কোনো বস্তু ধরিয়ে দিন	☐ ৪ – দুই পাশে ভালোভাবে ওজন সরিয়ে পিছনে তাকাতে পারে ☐ ৩ – এক পাশে ভালোভাবে তাকাতে পারে, অন্য পাশে ভারসাম্য কম ☐ ২ – পাশ ঘুরিয়ে তাকায় তবে ভারসাম্য বজায় রাখে ☐ ১ – ঘুরতে তত্ত্বাবধান প্রয়োজন ☐ ০ – ঘুরলে ভারসাম্য হারানোর আশঙ্কা, সহায়তা প্রয়োজন
৫.১১. ৩৬০ ডিগ্রি ঘোরা	সম্পূর্ণ একবার ঘুরে দাঁড়িয়ে আবার অন্যদিকে ঘুরুন	☐ ৪ – ৪ সেকেন্ড বা তার কম সময়ে নিরাপদে ঘুরতে পারে ☐ ৩ – একদিকে ৪ সেকেন্ড বা কম সময়ে নিরাপদে ঘুরতে পারে ☐ ২ – ধীরে হলেও নিরাপদে ৩৬০ ডিগ্রি ঘুরতে পারে ☐ ১ – ঘুরতে তত্ত্বাবধান বা মৌখিক সহায়তা প্রয়োজন ☐ ০ – ঘুরতে সহায়তা প্রয়োজন
৫.১২. দাঁড়িয়ে থাকা অবস্থায় একে একে পা স্টেপ বা টুলের ওপর রাখা	প্রতিটি পা ৪ বার করে স্টেপে রাখুন	☐ ৪ – স্বাধীন ও নিরাপদভাবে ২০ সেকেন্ডে ৮টি ধাপ সম্পন্ন করে ☐ ৩ – স্বাধীনভাবে করে তবে ২০ সেকেন্ডের বেশি সময় নেয়

		☐ ২ – তত্ত্বাবধানে ৪টি ধাপ সম্পন্ন করতে পারে ☐ ১ – ২টির বেশি ধাপ সম্পন্ন করতে পারে তবে সহায়তা দরকার ☐ ০ – সহায়তা ছাড়া করতে পারে না / ভারসাম্য রাখতে পারে না
৫.১৩. এক পা অন্য পায়ের সামনে রেখে দাঁড়িয়ে থাকা	এক পা সরাসরি অন্য পায়ের সামনে রাখুন, যাতে সামনে থাকা পায়ের গোড়ালি পেছনের পায়ের আঙুলের সঙ্গে স্পর্শ করে। যদি আপনি পা একেবারে সামনে রাখতে না পারেন, তাহলে এতদূর এগিয়ে একটি পা ফেলুন যাতে সামনে থাকা পায়ের গোড়ালি পেছনের পায়ের আঙুলের সামনে থাকে। পূর্ণ ৩ নম্বর পেতে, পদক্ষেপের দৈর্ঘ্য অপর পায়ের দৈর্ঘ্যের চেয়ে বেশি হতে হবে এবং আপনার দাড়ানোর প্রস্থ আপনার	☐ ৪ – স্বাধীনভাবে ৩০ সেকেন্ড ধরে রাখতে পারে ☐ ৩ – সামান্য সামনে রেখে স্বাধীনভাবে ৩০ সেকেন্ড ধরে রাখতে পারে ☐ ২ – ছোট পা ফেলা অবস্থায় স্বাধীনভাবে ৩০ সেকেন্ড দাঁড়াতে পারে ☐ ১ – সাহায্যে দাঁড়াতে পারে এবং ১৫ সেকেন্ড ধরে রাখতে পারে ☐ ০ – দাঁড়াতে গিয়েই ভারসাম্য হারায়

	স্বাভাবিক হাঁটার প্রস্থের কাছাকাছি হতে হবে।	
৫.১৪. এক পায়ে দাঁড়ানো	যতক্ষণ সম্ভব এক পায়ে দাঁড়িয়ে থাকুন	☐ ৪ – ১০ সেকেন্ডের বেশি স্বাধীনভাবে দাঁড়াতে পারে ☐ ৩ – ৫-১০ সেকেন্ড ধরে রাখতে পারে ☐ ২ – ≥ ৩ সেকেন্ড ধরে রাখতে পারে ☐ ১ – চেষ্টা করে কিন্তু ৩ সেকেন্ড ধরে রাখতে পারে না তবে পড়ে না ☐ ০ – চেষ্টা করতে পারে না বা পড়ে যাওয়ার আশঙ্কায় সহায়তা দরকার
মোট স্কোর		............./৫৬

মূল্যায়ন নির্দেশনা:

- ৪১–৫৬: পড়ে যাওয়ার ঝুঁকি কম
- ২১–৪০: মাঝারি ঝুঁকি
- ০–২০: উচ্চ ঝুঁকি

অংশ - ৬: হাঁটার মূল্যায়ন

টাইম আপ অ্যান্ড গো (TUG) টেস্ট

সাধারণ নির্দেশনা:

উদ্দেশ্য – গতিশীলতা মূল্যায়ন করা।

উপকরণ – স্টপওয়াচ।

নির্দেশনা – রোগী যেন নিজের সাধারণ জুতা পরিধান করে এবং প্রয়োজনে সাহায্যকারী যন্ত্র ব্যবহার করতে পারে। রোগীকে একটি সাধারণ চেয়ারে বসতে দিন এবং চেয়ার থেকে ৩ মিটার বা ১০ ফুট দূরত্বে মেঝেতে একটি রেখা চিহ্নিত করুন।

রোগীকে বলুন:

১.যখন আমি বলব "চলুন," তখন আপনি যা করবেন:

• চেয়ার থেকে উঠে দাঁড়াবেন।

• আপনার স্বাভাবিক গতিতে মেঝেতে চিহ্নিত রেখা পর্যন্ত হাঁটবেন।

• ফিরে ঘুরে দাঁড়াবেন।

• আপনার স্বাভাবিক গতিতে আবার চেয়ারে ফিরে আসবেন।

• আবার বসে পড়বেন।

২. "চলুন" শব্দটি বলার সাথে সাথে সময় গণনা শুরু করুন।

৩. রোগী যখন আবার চেয়ারে বসবে, তখন সময় গণনা বন্ধ করুন।

৪. সময় রেকর্ড করুন।

একজন প্রাপ্তবয়স্ক যদি এই কাজটি সম্পন্ন করতে ≥১২ সেকেন্ড সময় নেয়, তবে তার পড়ে যাওয়ার ঝুঁকি রয়েছে।

টাইম আপ অ্যান্ড গো (TUG) টেস্ট (সেকেন্ডে)	স্টপওয়াচে সময়

হাঁটার পরামিতি স্কেল

ধাপের দৈর্ঘ্য পরিমাপ (Step Length)

হাঁটার পরামিতি	পূর্বপরীক্ষা	পরপরীক্ষা
ধাপের দৈর্ঘ্য		

স্ট্রাইড দৈর্ঘ্য পরিমাপ (Stride Length)

মোট পদক্ষেপ =   মোট দূরত্ব =

হাঁটার পরামিতি	পূর্বপরীক্ষা	পরপরীক্ষা
স্ট্রাইড দৈর্ঘ্য		

গতির পরিমাপ (Speed)

দূরত্ব / সময় = গতি

দূরত্ব =   সময় =

হাঁটার পরামিতি	পূর্বপরীক্ষা	পরপরীক্ষা
হাঁটার গতি		

ক্যাডেন্স (Cadence)

১ মিনিটে মোট পদক্ষেপ সংখ্যা = ক্যাডেন্স

হাঁটার পরামিতি	পূর্বপরীক্ষা	পরপরীক্ষা
ক্যাডেন্স		

পরবর্তী পরীক্ষা (Post-test)

পরবর্তী পরীক্ষার তারিখ:

অংশ - ৫: বার্গ ব্যালেন্স স্কেল দ্বারা ভারসাম্য মূল্যায়ন

Berg Balance Scale (BBS) একটি ১৪-আইটেম বিশিষ্ট স্কেল যা পরিমাণগতভাবে ভারসাম্য মূল্যায়ন করে। প্রতিটি আইটেম ০ থেকে ৪ স্কোরে মূল্যায়ন করা হয়, যেখানে ০ মানে কাজটি সম্পূর্ণ করতে অক্ষম এবং ৪ মানে কাজটি স্বাধীনভাবে সম্পন্ন করতে সক্ষম। সর্বোচ্চ স্কোর ৫৬। এই অংশটি একজন ফিজিওথেরাপিস্ট পেন্সিল ব্যবহার করে পূরণ করবেন।

যে পয়েন্টটি রোগী সম্পাদন করতে সক্ষম, তা টিক ✓ চিহ্ন দিন)

প্রশ্ন	নির্দেশনা	প্রতিক্রিয়া
৫.১. বসা থেকে দাঁড়ানো	দয়া করে উঠে দাঁড়ান। হাত ব্যবহার না করার চেষ্টা করুন।	☐ ৪ – হাত ব্যবহার না করেই স্বাধীনভাবে দাঁড়াতে পারে ☐ ৩ – হাত ব্যবহার করে স্বাধীনভাবে দাঁড়াতে পারে ☐ ২ – কয়েকবার চেষ্টার পরে হাত ব্যবহার করে দাঁড়াতে পারে ☐ ১ – সামান্য সাহায্যে দাঁড়াতে পারে ☐ ০ – মাঝারি বা অতিরিক্ত সাহায্য ছাড়া দাঁড়াতে পারে না
৫.২. সমর্থন ছাড়া দাঁড়িয়ে থাকা	দয়া করে দুই মিনিট দাঁড়িয়ে থাকুন, কিছু না ধরে	☐ ৪ – নিরাপদে ২ মিনিট দাঁড়াতে পারে ☐ ৩ – তত্ত্বাবধানে ২ মিনিট দাঁড়াতে পারে

		☐ ২ – সমর্থন ছাড়াই ৩০ সেকেন্ড দাঁড়াতে পারে ☐ ১ – কয়েকবার চেষ্টা করে ৩০ সেকেন্ড দাঁড়াতে পারে ☐ ০ – ৩০ সেকেন্ড দাঁড়াতে অক্ষম
৫.৩. পায়ের নিচে মেঝে বা একটি স্টলে সহায়তা থাকা অবস্থায়, পিঠের পেছনে কোনো ভর বা সমর্থন ছাড়া বসা	দয়া করে দুই মিনিট হাত ভাঁজ করে বসে থাকুন	☐ ৪ – নিরাপদে ও নিশ্চিতভাবে ২ মিনিট বসে থাকতে পারে ☐ ৩ – তত্ত্বাবধানে ২ মিনিট বসতে পারে ☐ ২ – ৩০ সেকেন্ড বসতে পারে ☐ ১ – ১০ সেকেন্ড বসতে পারে ☐ ০ – ১০ সেকেন্ড বসতে পারে না
৫.৪. দাঁড়ানো থেকে বসা	দয়া করে বসে পড়ুন	☐ ৪ – খুব কম সহায়তায় নিরাপদে বসে পড়ে ☐ ৩ – হাত ব্যবহার করে নিয়ন্ত্রিতভাবে বসে পড়ে ☐ ২ – চেয়ারের পেছনে পা ঠেকিয়ে নিয়ন্ত্রণ করে বসে পড়ে ☐ ১ – স্বাধীনভাবে বসে পড়ে তবে নিয়ন্ত্রণহীনভাবে ☐ ০ – বসতে সাহায্যের প্রয়োজন

৫.৫. স্থানান্তর	একদিকে হাতলসহ এবং অন্যদিকে হাতলবিহীন চেয়ারে স্থানান্তর করতে বলুন	☐ ৪ – সামান্য হাত ব্যবহার করে নিরাপদে স্থানান্তর করতে পারে ☐ ৩ – হাতের ব্যবহার স্পষ্টভাবে দরকার হয় ☐ ২ – মৌখিক সহায়তা বা তত্ত্বাবধানে স্থানান্তর করতে পারে ☐ ১ – একজন ব্যক্তির সাহায্যে স্থানান্তর করতে পারে ☐ ০ – দু'জনের সহায়তা দরকার
৫.৬. চোখ বন্ধ করে দাঁড়িয়ে থাকা	দয়া করে চোখ বন্ধ করে ১০ সেকেন্ড স্থিরভাবে দাঁড়িয়ে থাকুন	☐ ৪ – নিরাপদে ১০ সেকেন্ড দাঁড়াতে পারে ☐ ৩ – তত্ত্বাবধানে দাঁড়াতে পারে ☐ ২ – ৩ সেকেন্ড দাঁড়াতে পারে ☐ ১ – চোখ বন্ধ রাখতে পারে না তবে নিরাপদে দাঁড়িয়ে থাকে ☐ ০ – পড়ে যাওয়ার ঝুঁকি থাকায় সাহায্য প্রয়োজন
৫.৭. একসাথে পা রেখে দাঁড়িয়ে থাকা	পা দুটি একসাথে রেখে দাঁড়ান এবং কিছু না ধরে থাকুন	☐ ৪ – স্বাধীনভাবে এক মিনিট নিরাপদে দাঁড়াতে পারে ☐ ৩ – তত্ত্বাবধানে এক মিনিট দাঁড়াতে পারে ☐ ২ – স্বাধীনভাবে দাঁড়াতে পারে তবে ৩০ সেকেন্ড ধরে রাখতে পারে না

		☐ ১ – অবস্থানে সহায়তা লাগলেও ১৫ সেকেন্ড দাঁড়াতে পারে ☐ ০ – অবস্থানে সহায়তা লাগলেও ১৫ সেকেন্ড দাঁড়াতে পারে না
৫.৮. হাত সামনে বাড়িয়ে দাঁড়িয়ে থাকা	৯০ ডিগ্রিতে হাত তুলে সামনে যতদূর পারেন বাড়িয়ে দিন	☐ ৪ – আত্মবিশ্বাসের সঙ্গে ২৫ সেমি পর্যন্ত পৌঁছাতে পারে ☐ ৩ – ১২ সেমি পর্যন্ত পৌঁছাতে পারে ☐ ২ – ৫ সেমি পর্যন্ত পৌঁছাতে পারে ☐ ১ – পৌঁছাতে পারে তবে তত্ত্বাবধান প্রয়োজন ☐ ০ – ভারসাম্য হারায় বা বাহ্যিক সহায়তা দরকার
৫.৯. নিচ থেকে বস্তু তোলা (দাঁড়িয়ে)	আপনার পায়ের সামনে রাখা স্লিপার তুলুন	☐ ৪ – নিরাপদে সহজেই তুলতে পারে ☐ ৩ – তুলতে পারে তবে তত্ত্বাবধান প্রয়োজন ☐ ২ – তুলতে পারে না তবে ২-৫ সেমি পর্যন্ত পৌঁছে ভারসাম্য বজায় রাখতে পারে ☐ ১ – তুলতে পারে না, চেষ্টা করলে তত্ত্বাবধান প্রয়োজন

		☐ ০ – চেষ্টা করতে পারে না / ভারসাম্য রাখতে সহায়তা দরকার
৫.১০. দাঁড়িয়ে থাকা অবস্থায় বাম ও ডান কাঁধের ওপর দিয়ে পিছনে তাকানো	আগে বাম কাঁধের ওপর দিয়ে পুরোপুরি পিছনে তাকান, তারপর ডান কাঁধ দিয়ে। প্রয়োজনে লক্ষ্য করার জন্য পেছনে কোনো বস্তু ধরিয়ে দিন	☐ ৪ – দুই পাশে ভালোভাবে ওজন সরিয়ে পিছনে তাকাতে পারে ☐ ৩ – এক পাশে ভালোভাবে তাকাতে পারে, অন্য পাশে ভারসাম্য কম ☐ ২ – পাশ ঘুরিয়ে তাকায় তবে ভারসাম্য বজায় রাখে ☐ ১ – ঘুরতে তত্ত্বাবধান প্রয়োজন ☐ ০ – ঘুরলে ভারসাম্য হারানোর আশঙ্কা, সহায়তা প্রয়োজন
৫.১১. ৩৬০ ডিগ্রি ঘোরা	সম্পূর্ণ একবার ঘুরে দাঁড়িয়ে আবার অন্যদিকে ঘুরুন	☐ ৪ – ৪ সেকেন্ড বা তার কম সময়ে নিরাপদে ঘুরতে পারে ☐ ৩ – একদিকে ৪ সেকেন্ড বা কম সময়ে নিরাপদে ঘুরতে পারে ☐ ২ – ধীরে হলেও নিরাপদে ৩৬০ ডিগ্রি ঘুরতে পারে ☐ ১ – ঘুরতে তত্ত্বাবধান বা মৌখিক সহায়তা প্রয়োজন ☐ ০ – ঘুরতে সহায়তা প্রয়োজন

৫.১২. দাঁড়িয়ে থাকা অবস্থায় একে একে পা স্টেপ বা টুলের ওপর রাখা	প্রতিটি পা ৪ বার করে স্টেপে রাখুন	☐ ৪ – স্বাধীন ও নিরাপদভাবে ২০ সেকেন্ডে ৮টি ধাপ সম্পন্ন করে ☐ ৩ – স্বাধীনভাবে করে তবে ২০ সেকেন্ডের বেশি সময় নেয় ☐ ২ – তত্ত্বাবধানে ৪টি ধাপ সম্পন্ন করতে পারে ☐ ১ – ২টির বেশি ধাপ সম্পন্ন করতে পারে তবে সহায়তা দরকার ☐ ০ – সহায়তা ছাড়া করতে পারে না / ভারসাম্য রাখতে পারে না
৫.১৩. এক পা অন্য পায়ের সামনে রেখে দাঁড়িয়ে থাকা	এক পা সরাসরি অন্য পায়ের সামনে রাখুন, যাতে সামনে থাকা পায়ের গোড়ালি পেছনের পায়ের আঙুলের সঙ্গে স্পর্শ করে। যদি আপনি পা একেবারে সামনে রাখতে না পারেন, তাহলে এতদূর এগিয়ে একটি পা ফেলুন যাতে সামনে থাকা পায়ের গোড়ালি পেছনের পায়ের আঙুলের সামনে থাকে। পূর্ণ ৩ নম্বর পেতে,	☐ ৪ – স্বাধীনভাবে ৩০ সেকেন্ড ধরে রাখতে পারে ☐ ৩ – সামান্য সামনে রেখে স্বাধীনভাবে ৩০ সেকেন্ড ধরে রাখতে পারে ☐ ২ – ছোট পা ফেলা অবস্থায় স্বাধীনভাবে ৩০ সেকেন্ড দাঁড়াতে পারে ☐ ১ – সাহায্যে দাঁড়াতে পারে এবং ১৫ সেকেন্ড ধরে রাখতে পারে ☐ ০ – দাঁড়াতে গিয়েই ভারসাম্য হারায়

	পদক্ষেপের দৈর্ঘ্য অপর পায়ের দৈর্ঘ্যের চেয়ে বেশি হতে হবে এবং আপনার দাড়ানোর প্রস্থ আপনার স্বাভাবিক হাঁটার প্রস্থের কাছাকাছি হতে হবে।	
৫.১৪. এক পায়ে দাঁড়ানো	যতক্ষণ সম্ভব এক পায়ে দাঁড়িয়ে থাকুন	☐ ৪ – ১০ সেকেন্ডের বেশি স্বাধীনভাবে দাঁড়াতে পারে ☐ ৩ – ৫-১০ সেকেন্ড ধরে রাখতে পারে ☐ ২ – ≥ ৩ সেকেন্ড ধরে রাখতে পারে ☐ ১ – চেষ্টা করে কিন্তু ৩ সেকেন্ড ধরে রাখতে পারে না তবে পড়ে না ☐ ০ – চেষ্টা করতে পারে না বা পড়ে যাওয়ার আশঙ্কায় সহায়তা দরকার
মোট স্কোর		............./৫৬

মূল্যায়ন নির্দেশনা:

- ৪১–৫৬: পড়ে যাওয়ার ঝুঁকি কম
- ২১–৪০: মাঝারি ঝুঁকি
- ০–২০: উচ্চ ঝুঁকি

<u>অংশ - ৬: হাঁটার মূল্যায়ন</u>

<u>টাইম আপ অ্যান্ড গো (TUG) টেস্ট</u>

সাধারণ নির্দেশনা:

উদ্দেশ্য – গতিশীলতা মূল্যায়ন করা।

উপকরণ – স্টপওয়াচ।

নির্দেশনা – রোগী যেন নিজের সাধারণ জুতা পরিধান করে এবং প্রয়োজনে সাহায্যকারী যন্ত্র ব্যবহার করতে পারে। রোগীকে একটি সাধারণ চেয়ারে বসতে দিন এবং চেয়ার থেকে ৩ মিটার বা ১০ ফুট দূরত্বে মেঝেতে একটি রেখা চিহ্নিত করুন।

রোগীকে বলুন:

১.যখন আমি বলব "চলুন," তখন আপনি যা করবেন:

• চেয়ার থেকে উঠে দাঁড়াবেন।

• আপনার স্বাভাবিক গতিতে মেঝেতে চিহ্নিত রেখা পর্যন্ত হাঁটবেন।

• ফিরে ঘুরে দাঁড়াবেন।

• আপনার স্বাভাবিক গতিতে আবার চেয়ারে ফিরে আসবেন।

• আবার বসে পড়বেন।

২. "চলুন" শব্দটি বলার সাথে সাথে সময় গণনা শুরু করুন।

৩. রোগী যখন আবার চেয়ারে বসবে, তখন সময় গণনা বন্ধ করুন।

৪. সময় রেকর্ড করুন।

একজন প্রাপ্তবয়স্ক যদি এই কাজটি সম্পন্ন করতে ≥১২ সেকেন্ড সময় নেয়, তবে তার পড়ে যাওয়ার ঝুঁকি রয়েছে।

টাইম আপ অ্যান্ড গো (TUG) টেস্ট (সেকেন্ডে)	স্টপওয়াচে সময়