Faculty of Medicine

University of Dhaka

Effects of Perturbation-Based Balance Training along with usual therapy for improving lower limb functional activity for people who experienced a stroke: A Randomized Controlled Trial.

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Master of Science in Physiotherapy

Bangladesh Health Professions Institute (BHPI)

Session: 2020-2021

Bangladesh Health Professions Institute (BHPI)

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May 2023

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TABLE OF CONTENTS

Acknowledgment	I
Acronyms	Ii
List of figures	iii
List of table	iv
Abstract	v
CHAPTER- I: INTRODUCTION	
1.1 Background	6-7
1.2 Rationale	8
1.3 Operational definition	9
1.4 Conceptual framework	10
1.5 Research question	11
1.6 Objectives	11
CHAPTER- II: LITERATURE REVIEW	12-23
CHAPTER- III: METHODOLOGY	24-32
3.1 Study design	24
3.2 Study site	24
3.3 Study Population	24
3.4 Sample size calculation	24
3.5 Duration of study	25
3.6 Eligibility criteria	25
3.6.1 Inclusion criteria	25
3.6.2 Exclusion criteria	25
3.7 Sampling Scheme	26
3.8 Sampling Technique	27
3.9 Interventions of the study	28-29

3.11 Method of data collection	30
3.12 Data collection Tools	30
3.13 Berg Balance Scale (BBS)	30
3. 14 Data analysis	31
3.14.1 Statistical test	31
3.14.2 Level of Significance	31
3.14.3 Treatment Regimen	31
3.15 Quality control and assurance	32
3.16 Ethical Issues	32
CHAPTER- IV: RESULTS	33-40
CHAPTER- V: DISCUSSION	41-44
CHAPTER- VII: CONCLUSIONS	45
CHAPTER- VIII: REFERRENCES	46-51
Appendix	73-90

Acknowledgement

First of all, I am grateful to almighty Allah for enabling me to complete this thesis. I am extremely grateful to my honorable and praiseworthy Supervisor Assistant Profesor Ehsanur Rahman for his excellent guidance from the very beginning to winding up of this study.

I am very much thankful to my data collectors, intern, Neurology unit of all staffs, incharge and Dr. Mohammad Anwar Hossain for their cordial support and permission for data collection at Neurology. I am also indebted to Prof. Md. Obaidul Haque, Vice Principal-BHPI, Md. Shofiqul Islam, Associate Professor & Head, Department. of Physiotherapy and also other faculty and board members for sharing their precious knowledge that enabled me to fine-tune various aspects concerning this study.

I want to remember all of my classmates and also thanks to Atikur Rahman, Md. Ershad Ali, two students with the feeling of gratitude for their inspiration and extending helpful hands in different situations throughout this study. I am very grateful to Librarian of BHPI for her support and other staffs for providing resources.

In fact, no amount of thanks is enough to acknowledge the role played by the study participants in making this dream in a reality.

Acronyms

BBS	Berg Balance Scale
BHPI	Bangladesh Health Professions Institute
CRP	Centre for the Rehabilitation of the Paralysed
CTRI	Clinical Trials Registry- India
DTFM	Deep transverse friction massage
FIM	Functional independence Measurement
GTFM	Gentle transverse friction massage
ICS	International Continence Society
MUI	Mixed Urinary Incontinence
PBBT	Perturbation-Based Balance Training
PFMT	pelvic floor muscle training
RCT	Randomized Clinical Trial
SCI	Spinal Cord Injury
SCIM	Spinal Cord Independence Measure scale
SCL	Spinal Cord Lesion
SE	Stabilization Exercise
SIP	Sickness Impact profile
SPSS	Statistical Package for Social Sciences
UI	Urinary Incontinence
WE	Walking Exercise
WHO	World Health Organization

List of Tables

Table 1	Socio demographic and clinical characteristics of participant	28
Table 2	Mann Whitney U test for between group analysis for total BBS	33
Table 3:	Within group analysis by wilcoxon sign rank test for individual variable	34

List of Figures

Figure 1: Flow Chart of The Phases Of Randomized Control Trial 26

Figure 2: Sex Of The Populations 34

Figure 3: Age Category 35

Figure 4 : Occupation of the Participants 36

Figure 5: Between Group Comparison of Mean Brag Balance Score. 39

ABSTRACT

Background: Stroke is a disorder where brain is damaged either by blockage in the blood vessels or rupture of the blood vessels. It is the approximately number five leading cause of death. It is also the leading cause of longer period disability as well as preventable cause of disability. **Objectives:** To determine and compare balance, functional mobility before and after application of perturbation-based balance training along with usual physiotherapy among patients with Stroke. **Methodology:** Classic experimental study design was used in this study. 60 patients with stroke were randomly assigned into two groups among them 30 patients were assigned into experimental group received perturbation-based balance training with usual physiotherapy and another 30 into control group received only usual physiotherapy. Total treatment sessions were twenty comprising of 3 sessions per week for 8 weeks. Single blinding procedure was used during data collection. Outcome measurement tools: Berg balance scale (BBS) was used to measure balance. Inferential statistics such as Mann-Whitney U test was used for between group analysis and within group analysis Wilcoxon test used by using SPSS version 22. **Results:** It was found that balance and functional mobility improved both between and within group results except standing unsupported one foot in front. **Conclusion:** This research showed that perturbation-based balance training with usual physiotherapy was more effective than only usual physiotherapy for patients with stroke.

Keywords: perturbation-based balance training, Usual Physiotherapy, Stroke

CHAPTER- I INTRODUCTION

1.1: Background of the Study:

A stroke is a regular, serious, and disabling problem in health care around the world. (Langhorne et al., 2011) found that stroke is the second or third most common cause of death and one of the main reasons why adults become disabled. "William Cole may have been the first person to use the word "stroke" in a medical article in 1689. It was in a physio-medical piece about the late occurrences of "apoplexies." Before Cole, apoplexy was the word most people used to talk about sudden brain damage that wasn't caused by an accident. It has been used for more than 2,000 years (Alharbi et al., 2019). Hippocrates used it around 400 BC.

Rehabilitation started soon after a stroke has been shown to help stroke patients avoid problems and have fewer functional problems after the stroke. It helps to improve the quality of life for stroke survivors by lowering functional disability and the number of complications (Whitehead & Baalbergen, 2019). It also lowers the cost of long-term care, which could be expensive.

Recent research shows that exercise treatment is the most important part of recovery from a stroke. Exercises done after a stroke can have different goals, such as goal-directed, task-oriented, or repetitive task training. They can also have different technical features, such as length, training load, and type of input. The goal of the Bobath treatment is to normalize tone and make it easier for people to move on their own by working on specific points like the trunk, pelvis, shoulders, hands, and feet. This helps people start and finish things they want to do. Hatem et al. (2016) say that both the person being treated and the doctor need to take an active role in the process.

For the lower limb, Muscle strengthening techniques are progressive active exercises in opposition to resistance. These exercises can be performed in opposition to a manual resistance exerted by the therapist. For years, the prevention of a range of joint motion loss, highly due to spasticity, has led to the application of arms stretch positioning during regular physiotherapy. Stretching may additionally be performed by hands-on physical therapy or with the aid of the application of devices such as cast, splint, and taping.

Bilateral training can be carried out with or without the assistance of an external device, the therapist instructs the stroke survivors to move the impaired upper extremity concurrently or alternating. In stroke rehabilitation, Constraint-induced movement therapy (CIMT) is a therapeutic approach that applies motor skill learning principles. It is a specialized task-oriented training approach (Hatem et al., 2016).

Perturbation-based balance training (PBT) is a sort of exercise in which participants frequently lose their equilibrium in order to learn and improve balance reaction control (Arvil et al., 2018). It differs from other balancing training programs in that it focuses on improving reactive balance control in order to avoid a fall after a balance failure in real life. PBT has been proven in studies to increase voluntary movement speed and control, improve fast balancing reflexes, and reduce the occurrence of falls (Alayat et al., 2022). An analysis of small-sample randomized controlled studies reveals that PBT can help elderly people and those with stroke by fall prevention. People who have had a stroke have decreased reactive balance regulation, and this is linked to greater fall rates in everyday life after a stroke. PBT is a tailored balance exercise program which can help a person with reactive balance control after a stroke (Avril et al., 2018).

Prior research in community for older individuals found that perturbation-based balance training improved reaction stepping. After 6 weeks (18 session of 30 minutes) of perturbation training, these older people used single stepping responses more frequently and had fewer foot collisions during sideward perturbations & improved overall lower limb balance, function (van Duijnhoven et al., 2018).

A systemic review and meta-analysis by Alayat et al. (2022) found that the benefit of PBT was stronger in patients with subacute stroke than in patients with chronic stroke, since patients recovered dramatically in the first few weeks following a stroke and then reached a relative plateau approximately 3 months later, with less meaningful recovery.

1.2: Rationale of the Study:

In Bangladesh, we have very few Rehabilitation centers where a person with a stroke finds appropriate physiotherapy treatment. Resistance training is commonly used in Stroke rehabilitation to decrease muscle tone and promote function. Hence there are research gaps in the general conventional physiotherapy for Stroke, including the guideline for practicing each component. From the different studies, it is evident that the functional status of the lower limb is a significant part of the rehabilitation of a person with a stroke. The individual functional and disability status may be varied according to age, gender, type of Stroke, phases of the Stroke, and chronicity of Stroke. It is imperative to find out the functional and disability status of lower limb function while a physiotherapy management team works towards the improvement or the recovery of the functional and disability status of stroke patients; otherwise, physiotherapy is not significant. Moreover, there is limited use of Perturbation based balance training for stroke people. Some evidence supports this training program but in Bangladesh, no analysis has been found in this area. As in Bangladesh, CRP has the facility to rehabilitate the people living with Stroke for a prolonged period, there is scope to introduce perturbation-based balance training in individualized structures for People with Stroke. The scope of practicing PBBT is fitted with the cultural context and organizational policy of CRP. The study results may help guide the physiotherapist and will give valuable information about stroke survivors' functional and disability status, which will be beneficial for both stroke survivors and for developing the platform of the physiotherapy profession.

The study is intended to elicit the effectiveness of PBBT on lower limb functional recovery in patients with sub-acute stroke.

1.3: Operational Definition:

Stroke: Stroke may be define as rapidly developing of clinical signs which lasting more than 24 hours with no apparent cause of vascular origin or leading to death. It is a clinical syndrome.

Perturbation-based balance training (PBT): Perturbation-based balance training is a sort of exercise in which participants frequently lose their equilibrium in order to learn and improve balance reaction control (Arvil et al., 2018).

Usual therapy: Usual physiotherapy is a group of selected treatment techniques set by a physiotherapist on the basis of evidence that are widely used around the world for the treatment of specific disease (Kishner & Colby, 2007).

BMI: A consistent approximation of an individual's comparative body fat calculated from his or her height or weight. The formula for calculating BMI is weight in kilogram (kg) divided by height in meter (m) squared.

1.4 Conceptual framework

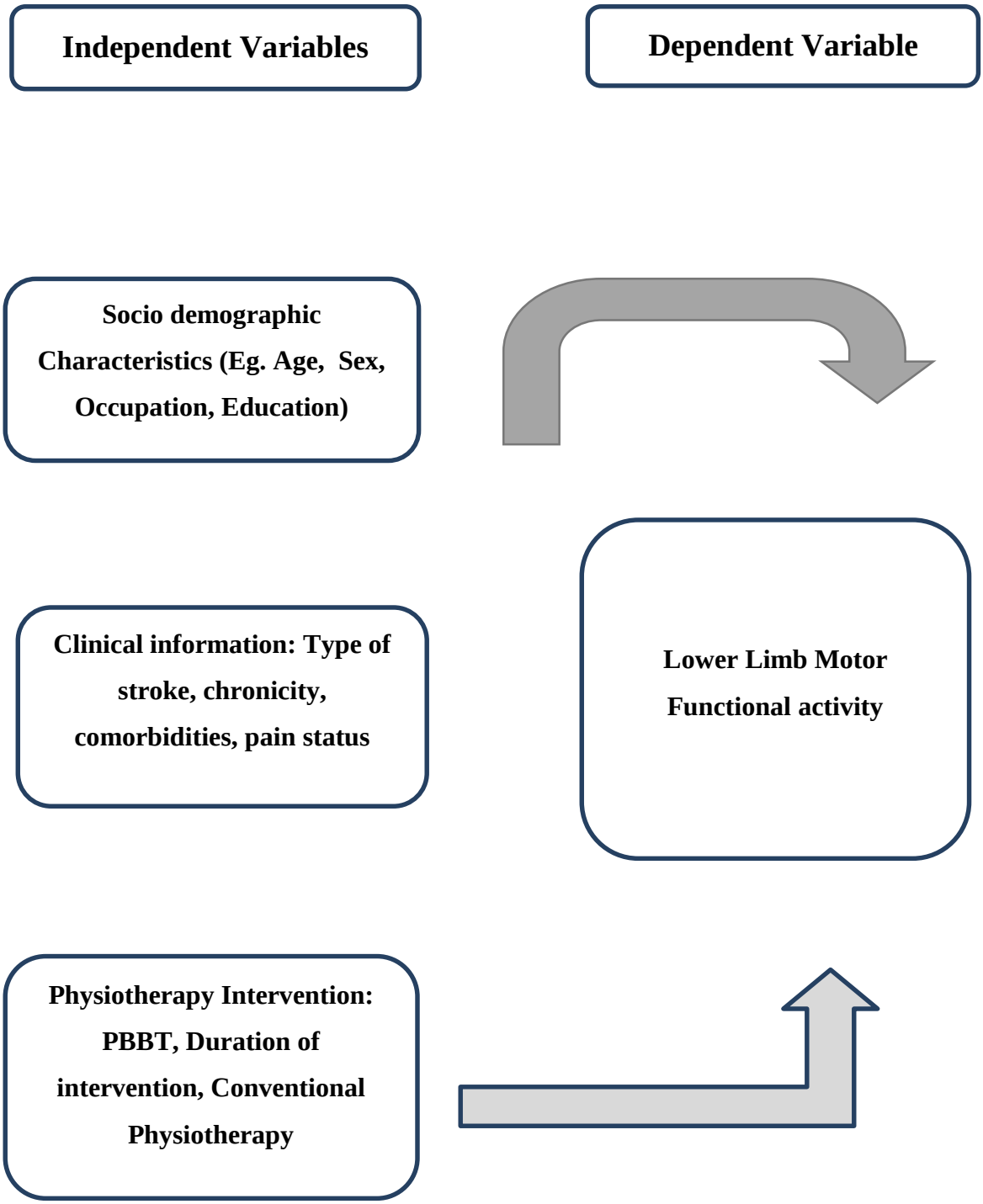

Figure 1: Conceptual framework

1.5 Research Question:

What is the effectiveness of perturbation-based balance training exercise for patients who had stroke?

1.6 Objectives:

1.6.1 General Objective:

The aim of the study is to elucidate the effects of Perturbation-Based Balance Training (PBBT) along with usual therapy for improving lower limb functional activity for patient with stroke in Subacute Persons with Stroke.

1.6.2 Specific Objectives:

i. To delineate the demographic status of the people with stroke.
ii. To inspect the effectiveness of PBBT on sub-acute stroke patients on balance and lower limb functional activity of patients with stroke.

1.7 Research Hypothesis

Null Hypothesis:

Null Hypothesis $H0 = \mu1 - \mu2 = 0$ or $\mu1 = \mu2$, where the post test and pretest initial and the final mean difference is the same. Perturbation-Based Balance Training along with usual therapy are no more effective for improving lower limb functional activity for patients with subacute stroke.

Alternative Hypothesis:

Alternative Hypothesis $H\alpha = \mu1 - \mu1 \neq 0$ or $\mu1 \neq \mu2$, where the post test and pretest initial and the final mean difference is not the same. Perturbation-Based Balance Training along with usual therapy are more effective than only usual therapy for improving lower limb functional activity for patients with subacute stroke.

CHAPTER-II LITERATURE REVIEW

William Cole most likely coined the term "stroke" for the first time in 1689 in a physico-medical study on the late frequencies of apoplexies. Before Cole, apoplexy was the term most frequently used to refer to acute non-traumatic brain injury. Hippocrates utilized it for more than 2000 years beginning in the year 400 BC.
Stroke is “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 that of vascular origin” (Alharbi et al., 2019).

Awada et al. (1999) found that 76% of cases were ischemic strokes, and one-third of those were lacunar infarcts. Most of the bleeding strokes were intracerebral hemorrhages, or ICHs. Other studies with similar data showed that the number of ischemic strokes would be higher..

According to data from 2005 and the American Heart Association Heart Disease, most strokes (88%) are caused by a blockage in the blood flow to the brain. About 12% of strokes are caused by bleeding. Hemorrhagic strokes are more likely to lead to death within 30 days than ischemic strokes (American Heart Association, 2003, Heart disease and stroke data). In Bangladesh, statistics from Mondal et al., 2022 showed that men were twice as likely as women to have a stroke (13.62 per thousand vs. 8.68 per thousand). In rural areas, the number was a little bit higher (11.85 vs. 11.07). About 50.4% of the people who took the poll said they knew something about stroke. Out of the 288 cases that were looked at, 79.7% (213) had ischemic strokes, 15.7% (42) had hemorrhagic strokes, and 4.6% (12) had cerebral hemorrhages. Hypertension was found in 79.2% of stroke patients, followed by cholesterol (38.9%), smoking of any kind (37.2%), diabetes (28.8%), and ischemic heart disease (20.1%).

The fall-associated volitional balance control domain has profited most from exercise-based conventional training; however, the influence on reactionary balance control is under-examined. Consequently, the aim of this study was to investigate the impact of

traditional exercise-based training on reactive balance control (Kannan et al., 2020). Older adult falls cost the US healthcare system $19 billion in 2000. In just 15 years, this amount increased by 63% to 31 billion dollars. Falls rose by 50% between 2001 and 2008, and as the older population has expanded, so have related health care expenses. Falls are the most frequent medical complication following a stroke, with stroke patients 1.77 times more likely to experience them than older persons without impairment. For this vulnerable demographic, there is an obvious need for measures that effectively prevent falls. Trip-specific training is a focused training method that helps amputees and elderly persons have fewer falls. Trainees experience treadmill disturbance Trainees can practice responding to conditions that arise during community trips thanks to treadmill perturbations, which imitate overground journeys. Trips are a focus since they are one of the leading causes of falls in seniors and people who have had strokes. When compared to control groups, trip-specific training lowers older women's fall risk in the lab by 83.2% and in the community by 50%. travel-related instruction achieves this quickly in 4 hours spread over 2 weeks.es during trip-specific training in a safe environment where injuries are not likely (Nevisipour et al., 2019).

According to evidence provided by Dusane et al., (2020), up to 70% of patients with chronic stroke (PwCS) experience falls after leaving hospitals and rehabilitation centers. Therefore, falls continue to be a major health concern, particularly as these PwCS regain community ambulation and are exposed to environmental perturbations from the outside, which account for 34% of falls. Several conventional balance training programs have been developed to decrease falls, but due to a lack of task specificity, these therapies have not proven more successful. Therefore, it is crucial to provide task-specific training paradigms that include unforeseen disturbances that can cause instability and a sudden loss of balance in order to elicit the proper protective, reactionary reactions, such as compensatory stepping or grasping for recovery and fall prevention. These unexpected perturbations, in contrast to conventional training, concentrate on honing reactive responses under circumstances that are similar to real-life perturbations, such as a loss of balance brought on by accelerations/decelerations while standing in the bus or a loss of balance brought on by an external perturbation, like a push or nudge, while performing daily activities, transfers, or walking on crowded city sidewalks.

Gerards et al., (2017) and his team directed a systematic literature search based study mentioning that, for our aging societies, falls and fall-related injuries are a major public

health concern. A fall occurs in about 30% of adults over the age of 60 each year, with older age and frailty both independently raising the chance of falling. Fall risk is much higher among older persons with neurological conditions like Parkinson's disease and stroke. Evidence-based therapies for preventing falls and fall-related injuries in older populations are crucial because falls are a primary cause of injury, hospitalization, and even death in older persons. After exercise programs that included a mix of strength, balance, and aerobic exercises, healthy older individuals saw moderate falls risk reductions (about 15-20%). There is conflicting evidence, nevertheless, about whether or not these exercise treatments help older, fragile people experience fewer falls. Importantly, there is scant evidence that falls risk can be reduced in older persons with Parkinson's disease or following a stroke with such strength and balance exercise regimens. Lack of task specificity in the recovery actions necessary to prevent a fall is one potential cause of the inconsistent results or ineffectiveness of such general exercise treatments for falls reduction. Change-in-support actions (such as taking compensating steps or holding adjacent objects for support) and counter rotations of body segments can be used to regain balance after a postural disruption. It may be more beneficial to train these systems for recovering balance.

Mansfield et al., (2015) in their systemic review & meta-analysis stated that perturbation-based balance training (PBT) is a unique balance training technique that involves exposing the subject to frequent postural perturbations to elicit quick balance reactions. With experience, the subject can become more adept at controlling these reactions. Due to the extra speed and stability demands of balance reflexes, the alternative—training voluntary motions (such as voluntarily executed stepping or reach-to-grasp movements—will probably not result in improved reactive balance control). Studies have demonstrated that PBT can decrease the frequency of "falls" (into a safety harness) after controlled postural perturbations in the laboratory. It can also increase the speed and control of voluntary movements and rapid balance reactions. Even though there are numerous risk factors for falls, a specific fall event only happens when a person is unable to recover from a loss of balance or postural disturbance. In daily life, postural disturbances can happen for a number of reasons, such as inability to control weight shifting during voluntary movement or tripping or slipping while walking. Following a postural perturbation, quick balance recovery activities are taken to avoid falling, such as swaying around the ankles or hips,

taking a step, or gripping a handhold. People who have trouble controlling these balance recovery processes frequently have trouble controlling their balance and are more likely to fall. PBT's impact on the likelihood of falls in daily life hasn't been proven decisively, though. In several trials with small sample sizes, the trained group's fall rates were non-significantly lower than those of the control group. By conducting a thorough search for and meta-analysis of published and unpublished data from randomized controlled trials, they were able to estimate the effect of PBT on risk of falls in daily life among people who are at increased risk for falls (i.e., older adults and people with neurological conditions).

One of the popular article about lower extremity perturbation training published in strength and conditioning journal by Taylor, (2011) enumerated briefly about lower extremity perturbation balance training program and training induce physical responses. According to article statements, enhancing movement patterns, muscle activation, balance, proprioception, and agility are the main goals of neuromuscular training. It is a common technique used in injury prevention and recovery when combined with strength training. The results of research on neuromuscular training include decreased incidence of ligament injuries in the lower extremities, enhanced movement biomechanics, dynamic balance, and functional status. The use of controlled, unexpected, and multidirectional pressures to upset balance is one method of neuromuscular training. Aiming to improve the efficiency of stabilizing muscular contractions during stance or gait, lower extremity perturbation training involves controlled unpredictable forces directed to an unstable surface. It's a kind of neuromuscular training that improves neural pathways to support efficient muscular recruitment patterns and dynamic joint stability. Perturbation training has been demonstrated to be effective in the preoperative management of anterior crusae ligament rupture and reconstruction when combined with other neuromuscular techniques. Other athletic injuries may also be prevented and rehabilitated by the effects of training. Fundamentally, perturbation training is a more sophisticated kind of balancing training. The three sensory systems that the human body uses to maintain balance are continuously combined. The somatosensory, vestibular, and visual systems are all put to the test during perturbation training; however, the visual and vestibular systems often are not affected, and the majority of adaptations occur within the somatosensory system. The somatosensory system is made up of several receptors that can distinguish between

distinct feelings. Proprioceptors are a class of somatosensory receptors that detect changes in muscle length, joint angle, and tension. To comprehend the physiological advantages of perturbation training, one must have a basic understanding of the operation of the muscle spindle, a type of proprioceptor. Parallel to extrafusal muscle fibers are located muscle spindles. The muscular spindle, which is made up of intrafusal muscle fibers, afferent nerve endings, and gamma motor nerves, participates in the stretch reflex by responding to changes in muscle length or the rate of tissue length change and regulates the activity of alpha motor neurons. With surface perturbation training, modifications in the surface's stability cause the affected musculotendinous units to quickly stretch. After a brief stretch, the muscle spindle receives and transmits neural signals in an effort to reestablish stability by contracting the stretched muscles and inhibiting an opposing reaction. The threshold, or sensitivity, for a muscle spindle to react to different amounts of stretch is set by gamma innervation. A slower reaction time results from proprioceptive input being delayed even more with weariness). To hasten this response, perturbation training is used. The agonistic musculature can respond to lower unexpected forces with a faster reaction time by lowering the thresholds of the mechanoreceptors. A higher level of readiness to identify and react to destabilizing influences may arise from this. As a result of perturbation training, these sensorimotor adaptations produce observable physical alterations. Athletes' gait status and their capacity to resume their previous sport or functional activities are improved by these responses, which also include alterations in the muscular contraction around a joint, improved muscle recruitment and activation, and rapid anticipatory reactions. Although the majority of recent research demonstrates the advantages of perturbation training during preoperative care and nonsurgical care of anterior cruciate ligament (ACL) injury, it is also utilized as a treatment in rehabilitation settings for various knee and ankle pathologies associated with stroke as well as balance impairment.

Chayasit at al., (2022) in their RCT study definited that, with perturbation training, protective stepping can be honed using sophisticated tools (such a moveable platform or a cable-release system) . After a single session of slip exposure, people with chronic stroke have seen positive effects of perturbation training in response to platform translations. The subjects' protective step lengths, number of terminating steps, and stability all improved after training. In a case study utilizing a cable-release method, similar outcomes were discovered. With the use of a cable, a participant with a chronic stroke leaned forward,

and the wire was suddenly released to cause protective stepping. The outcomes showed that the individual could respond to a larger magnitude of disruption without any outside help after 6 training sessions. However, the utilization of these training techniques in actual clinical settings is restricted since they need for expensive, bulky, and complicated equipment that is rarely available.

Mansfield et al., (2015) in their RCT study stated that, reactive balance regulation is crucial for preserving balance and movement, according to prior study. While external circumstances (such as a slippery floor or nudge) can cause falls, the ability to regain balance and stop falling is primarily governed by the efficacy of balance reflexes. Fixed support reflexes, such as hip and ankle motions, maintain balance without affecting the base of support. They are helpful in protecting against minor postural disturbances. However, the key to preventing falling is change-in-support reflexes, which involve quick stepping and gripping movements. The importance of reactive stepping is demonstrated by records of naturally occurring falls and near falls, demonstrating that this response is not just reserved for the most severe postural perturbations. Perturbation training and movement speeds, amplitude and trajectory scaled to the degree of instability, and the capacity to adapt to changing environmental conditions are the characteristics of reactive stepping. These traits place heavy demands on stroke sufferers, making it challenging to manage such reactions. Heightened risk of falling and increased fear and anxiety are caused by impaired limb control, which delays the execution of compensatory steps, or by dyscoordination, which makes foot placement or weight bearing challenging. People with impaired balance control are more and more reliant on these stepping responses since they are the last line of defense against falling, despite the control issues that come with doing so. It is crucial to create strategies to retrain compensatory stepping after a stroke since stroke survivors have a higher risk of falling.

Schinkel-Ivy et al., (2019) in their RCT study mentioned that, Traditional balance training (TBT), which focuses on maintaining stability during voluntary movement, helps older adults avoid falling, but programs like these don't lower fall rates in those who have had a stroke. In order to increase reactive balance control and lower the chance of falling, perturbation-based balance training (PBT) emphasizes practicing reactions to instability. PBT decreases the incidence of multistep reactions, foot collisions, and response times to auditory stimuli in older persons. An individual with subacute stroke who had PBT showed improved reactive step timing and the capacity to step with the nonpreferred

stepping leg. Collectively, these results suggest that PBT might enhance reactive stepping poststroke. PBT may help people with chronic strokes improve their reactive balance control, according to preliminary research. As a result, reactive stepping traits that get better after PBT must be found. Our understanding of reactive balance control in stroke patients will increase as we pinpoint the mechanisms by which improvements take place. We may also be able to develop PBT for use in clinical settings.

A randomized, controlled trial was conducted with subacute stroke patients. In the experimental group (n=18), PBBT (Perturbation-Based Balance Training) was used to assist participants with impaired balance and movement while they engaged in task-oriented Balance training activities under the supervision of a therapist. In the control group (n=16), standard rehabilitation care including weight shifting and gait training (WS & GT) protocol was administered. The intervention protocol for both groups consisted of 12 training sessions of 30 minutes each, conducted daily for 2.5 weeks. The PBBT included unanticipated disturbances in balance while standing and walking on a treadmill, whereas the WS&GT included weight shifts while standing and walking on a treadmill without disturbances. Multiple step-threshold and fall threshold parameters were evaluated at baseline, immediately following the intervention, and approximately 5 weeks after the intervention. The BBS, the 6-minute walk test (6MWT), the 10-meter walk test (10MWT), and the Activity-specific Balance Confidence (ABC) scale were utilized as secondary outcome measures at baseline and immediately postintervention (Handelzalts et al., 2019).

An assessor-blinded randomized controlled trial was conducted by (Mansfield et al., 2018) to compare the effectiveness of Perturbation based balance training (PBBT) preventing fall tendency in patients with chronic stroke. Total 83 participants with chronic stroke were recruited & separated into two groups 42 (control) & 41 (PBT group). PBT groups focused on improving response to instability whereas traditional balance training for control group focused on maintaining stability during functional task for control group. Training sessions lasted one hour twice a week for six weeks. During the follow-up, participants were also invited to attend two 'booster' training sessions. The primary result was the number of falls in the 12 months following training. To compare fall rates between groups, negative binomial regression was utilized. Measures of balance, mobility, balance confidence, physical activity, and social integration were secondary outcomes.

Another systematic review & meta-analysis of randomized control tails manifested by Mansfield et al., (2015) with total number of 8 RCT studies from 761 articles which are highly impactful presented that , six out of the eight investigations, participants in the PBT group fell less frequently after training than in the control group. The total risk ratio for all 8 studies put together was 0.71 (95% CI0.52, 0.96; P.02; Fig. 2); participants who completed PBT were less likely to fall than those in the control groups. In comparison to the control group, the PBT group experienced fewer falls, according to six out of the eight trials. In general, PBT participants reported fewer falls in daily life than individuals in the control groups. In total, there were 8 studies included, and the rate ratio was 0.54 (95% CI 0.34, 0.85; P.007; Fig. 3). Comparisonal tabulation format is given below: -

Savin et al., (2014) conducted a randomized controlled trail in which they included 10 participants with stroke and hemiparesis and 10 controls walked overground on an instrumented gait mat, adapted gait to a swing phase perturbation on a treadmill, then walked overground on the gait mat again. Outcome measures, primary: overground step length symmetry, rates of treadmill step length symmetry adaptation and overground step length symmetry readaptation; secondary: overground gait velocity, stride length, and stride cycle duration. Effects of step length symmetry extended to overground walking and adapted on the treadmill in both groups at a similar pace. Participants who had suffered a stroke experienced a slower overground decline of the effects, which temporarily reduced step length asymmetry. Due to longer strides and shorter stride durations, both groups' overground gait velocity increased after adaptation. Stroke and hemiparesis prolong overground effects but do not affect the generalization of step length symmetry alterations from adapted treadmill to overground walking. After a stroke, motor adaptation while walking on a treadmill may be a successful treatment for reducing overground gait asymmetries. Effects of step length symmetry extended to overground walking and adapted on the treadmill in both groups at a similar pace. Participants who had suffered a stroke experienced a slower overground decline of the effects, which temporarily reduced step length asymmetry. Due to longer strides and shorter stride durations, both groups' overground gait velocity increased after adaptation. Stroke and hemiparesis prolong overground effects but do not affect the generalization of step length symmetry alterations from adapted treadmill to overground walking. After a stroke, motor

adaptation while walking on a treadmill with perturbation training may be a successful treatment for reducing overground gait asymmetries.

Another RCT studies conducted by Dusane et al., (2020) exhibited that Twelve PwCS living in the community who could ambulate on their own and were at least six months post-cortical stroke were included in the study. The Montreal Cognitive Assessment Scale score of 26/30, the Mississippi Aphasia Screening Test score of 71/100, the ultrasound score of 1 for low bone density, and any other self-reported medical or surgical disorders precluded participants from participating. Basic clinical measurements were evaluated, including the Chedoke-McMaster Stroke Assessment scale, the Berg Balance Scale, the Timed Up-and-Go test, the Chedoke-McMaster Stroke Assessment scale for stroke impairment, and the 6-Minute Walk Test for cardiovascular endurance testing. Standing on the ActiveStep (Simbex) motorized treadmill with their feet around shoulder-width apart, all participants experienced perturbations that resembled slips or trips. Participants were securely fastened with a safety harness to keep them from touching the treadmill belt in the case of a fall. All participants were told to make an effort to regain their equilibrium after losing it in order to prevent falling. The Active Step (AS) predefined intensity level II (12 m/s2) was applied to all participants in a block of 11 abrupt, unexpected slip-like stance perturbations (S1-S11) and the AS level III (16.75 m/s2) was applied in a block of 11 trip-like stance perturbations (T1-T11) (Fig. 1). After that, five slip like perturbations at AS level II (12 m/s2) and five trip like perturbations at AS level III made up mixed-stance perturbation training. Positive reaction responses were developed as a result of block perturbation training to combat treadmill-based stance disturbances resembling trips and slips in persons with chronic stroke. Throughout mixed block, previously obtained adaptive modifications in slip-block training did not preserve the reflexive responses, perhaps as a result of trip block's interference. Instead, go on a trip block-induced adaptation was kept up and continued to demonstrate improvement in the presence of disturbances.

Nevisipour et al., (2019) on their RCT study enrolled on 16 individuals with unilateral chronic stroke conducted in USA demonstrated that a single trip-specific training session with 15 treadmill perturbations involved sixteen patients with unilateral chronic stroke. Before and after training, a falls evaluation comprised of three perturbations was completed. A repeated measures approach was used to compare the recovery step

kinematics recorded at the pre- and post-test. Additionally, Fallers (individuals who fell at least once during the pre- or posttest) and non-fallers were contrasted. Trunk movement following disturbance was reduced by trip-specific training. In particular, by the conclusion of the first compensatory step after training, trunk flexion was 48 and 19 percent less on the mild and medium perturbations, respectively. Fallers post-training (nine out of 16 individuals) resembled non-Faller's pre-training. Particularly, there was no difference between Fallers post-training and non-Faller's pre-training in trunk flexion at the end of the first step during mild and medium perturbations. Even so, excitement was muted because overall falls did not decrease as a result of this training because trunk flexion at the biggest disturbance, when the majority of falls occurred, was unaffected. The results of this study showed that the single-session trip-specific training strategy altered trunk control in all individuals, with Fallers demonstrating the greatest changes and having post-training kinematics that were similar to those of non-fallers pre-test. Trip-specific training improves the efficiency of the compensatory stepping reaction needed to recover from falling as indicated by trunk control. Even yet, trip-specific training may be ineffective unless it addresses the neuromuscular deficiencies that people with stroke may have, including as muscle weakness, spasticity/flaccidity, aberrant muscle synergies, and decreased motor learning capacity. The effects of a training program that included postural perturbations on falls and stepping responsiveness in stroke patients have only been studied by two groups. Although there is a change in the compensatory stepping response (less trunk movement), laboratory-induced falls do not diminish. This suggests that in order to result in a reduction in fall outcomes, the conventional dosage of trip-specific training may need to be altered, prolonged, or used in concert with other fall prevention techniques. A randomized controlled trial with sub-acute stroke patients was carried out. In the experimental group (n=18) the PBBT (Perturbation Based Balance Training) was applied to support impaired balance & movements while the participant was working on task-oriented Balance training activities under guidance of the therapist. In the control group (n=16), participants were treated with standard rehabilitation care that included weight shifting and gait training (WS & GT) protocol. The intervention protocol for both groups received 12 training sessions, lasting for 30 minutes each that were applied every day for 2.5 weeks. The PBBT included unanticipated balance disturbances while standing and treadmill walking, whereas the WS&GT included weight shifting while standing and treadmill walking without perturbations.

Multiple step-threshold and fall threshold parameters were assessed at baseline, immediately postintervention, and about 5 weeks postintervention. BBS, 6-minute walk test (6MWT), 10-meter walk test (10MWT), and Activity-specific Balance Confidence (ABC) scale were used as secondary outcome measures at baseline and immediately postintervention (Handelzalts et al., 2019).

An assessor-blinded randomized controlled trial was conducted by (Mansfield et al., 2018) to compare the effectiveness of Perturbation based balance training (PBBT) preventing fall tendency in patients with chronic stroke. Total 83 participants with chronic stroke were recruited & separated into two groups 42 (control) & 41 (PBT group). PBT groups focused on improving response to instability whereas traditional balance training for control group focused on maintaining stability during functional task for control group. Training sessions lasted one hour twice a week for six weeks. During the follow-up, participants were also invited to attend two 'booster' training sessions. The primary result was the number of falls in the 12 months following training. To compare fall rates between groups, negative binomial regression was utilized. Measures of balance, mobility, balance confidence, physical activity, and social integration were secondary outcomes.

CHAPTER-III METHODOLOGY

3.1. Study Design:

Randomized control trial (RCT) study was used to find out the appropriate result of this study. Because this study design is the easiest design to find out the relationship between independent variable and dependent variable by formulating a hypothesis (Hicks, 1999). This randomized controlled trial study consisting of two parallel arms one arm received perturbation-based balance training along with usual physiotherapy entitled as experimental group and another arm received only usual physiotherapy which was entitled as control group.

3.2 Study Site

The study was conducted from Stroke Rehabilitation Unit and outpatient neurology physiotherapy unit of center for rehabilitation of the paralysed (CRP), Savar, and Dhaka 1343.

3.3 Study Population

All stroke patients who were admit at Centre for the Rehabilitation of the Paralysed (CRP), Savar in a study period was consider as a population of this study.

3.4 Sampling Technique

A convenient selection of 30 stroke victims who matched the inclusion criteria were chosen from the outpatient neurological unit of the physiotherapy division of CRP, Savar, Dhaka. All of the participants had an equal chance of being assigned to one of the two groups, and for this study, 15 patients were randomly assigned to the experimental group, which included Perturbation-Based Balance Training (PBBT) along with traditional physiotherapy, and 15 others to the control group, which received standard conventional therapy. In this investigation, a single blinding process was used. By employing a computer-generated random number between the range of 1 and 30, the participants were divided into the experimental group and the control group. The participants of the

experimental and control groups were first randomly assigned by computer, with the first participants appearing in the experimental group.

3.5 Sample Size:

A power analysis to determine sample size with 1.14% prevalence of stroke in Bangladesh (Mondal et al., 2021) where 5% types – I error (α), 80% power (1 – type II error/β) and a clinically acceptable margin, δ = 0.1, then according to Zhong (2009),

$$N = 2 \times \left(\frac{Z_{1-\alpha}+Z_{1-\beta}}{\delta}\right)^2 \times p \times (1-p)$$
$$= 23.66 \approx 24$$

Here,
$1 - \alpha = 0.95$
$1 - \beta = 0.80$
$Z\ (0.95) = 1.96$
$Z\ (0.80) = 1.28$

Considerable dropout rate is 20% for the study, we will recruit 30 participants for each group.

3.6 Duration of study

The duration of the study was 7 Months, from October 2022 to April 2023.

3.7 Eligibility Criteria

3.7.1 Inclusion Criteria of the participants:

Patients who were

- The diagnosis of a first-ever stroke was supported by a head CT or MRI scan
- 2 months to 4 months after stroke onset
- 30 to 85 years of age
- Brunnstrom recovery stage one to four for the affected upper limb
- Unilateral lesion indicated by CT or MRI,
- Attend voluntarily for this study with a signed informed consent.
- Well general condition with stabilized vital signs and normal consciousness

3.7.2. Exclusion Criteria of the participants:

- Reversible stroke.
- Hemorrhagic stroke
- Severe visceral organ (e.g., heart, lung, liver, and kidney) dysfunction
- Severe diagnosed cognitive dysfunction
- History of diagnosed mental disease and could not cooperate in rehabilitation treatment
- Unable to receive treatment in designated hospital at specific time or unable to be followed up regularly
- Implanted with cardiac pacemaker with upper limb dysfunction due to other causes

3.8 Sampling Scheme

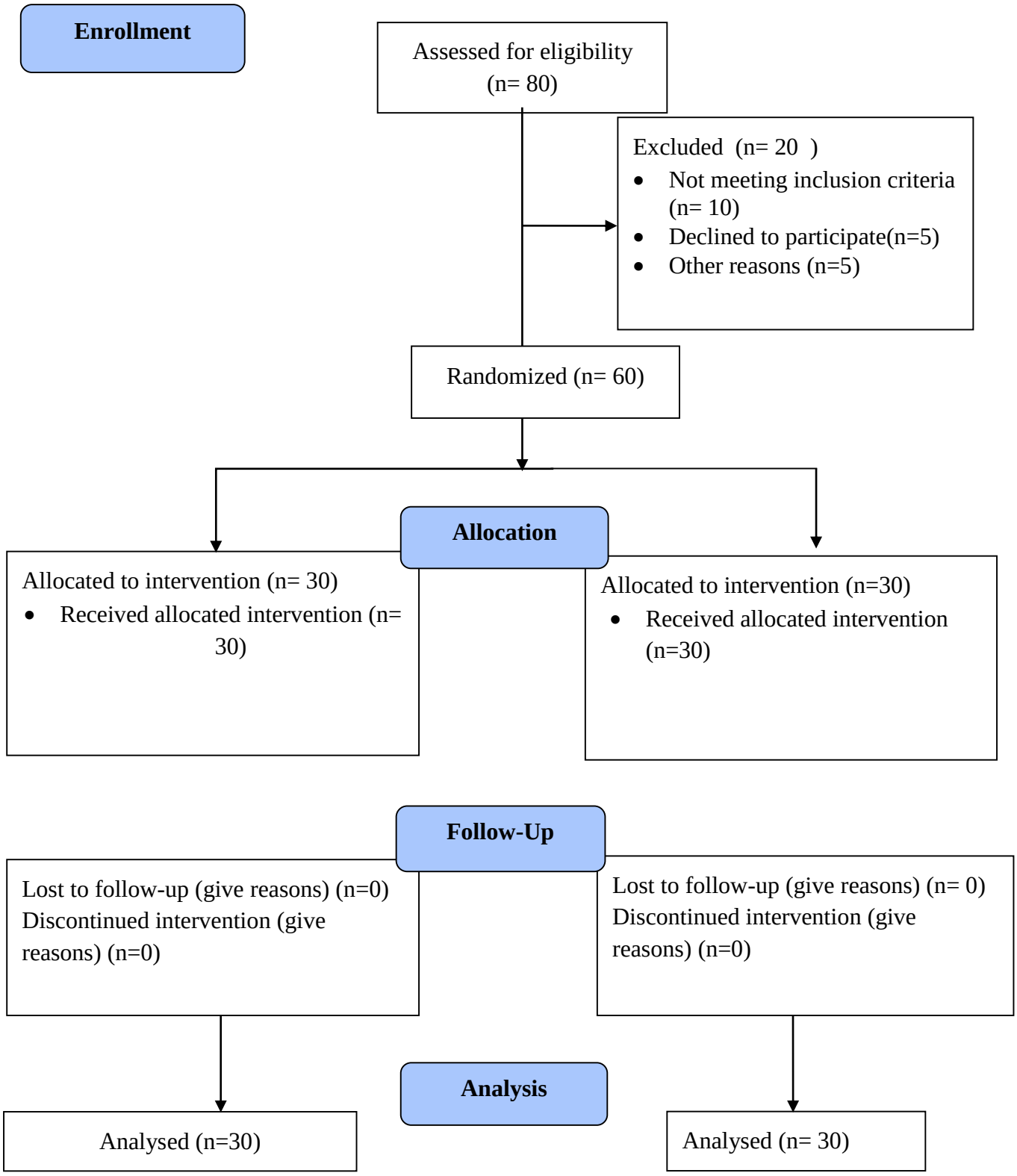

Figure 1: Consort flow chart of the phases of Randomized Control Trial

Intervention Protocol

Protocol for perturbation based balance training

- **Step up:** Patient takes step on with single leg then progress to double leg standing on uneven or unpredictable surface with physical perturbation (e.g. firm pads, bosu ball or rocker board).
- **Balance board exercise:** The subject stands on a tilt board or balance board with both feet on the board. The therapist perturbs the tilt board in forward and backward and side-to-side directions. The activity may begin with subject in the semi-seated position, with hips resting on plinth if the subject has difficulty doing the activity in full standing lasts approximately 30 seconds 10/20 time will be selected by physiotherapist according to patient's condition. The activity is repeated by changing the limbs on the platform and the roller board.
- **Kicking a ball Exercise**: Dosage/progression: - approximately 30 seconds for 10/20 time will be selected by physiotherapist according to patient's condition. Difficulty is progressed as the subject improves by progressing to ball catching with therapist perturbing subject's balance.
- **Stand and walk:** The subject stands with one limb on a stationary platform and then started walking with other limb. Exercise dosage/progression: Approximately 30 seconds each and repetition will be selected by physiotherapist prior to patient's physical condition.
- **Obstacle course:** Subject stands on an obstacles surface with both feet on the ground. Therapist attempts to perturb patient balance in random fashion. Exercise dosage/progression:
- **Walk and carry:** Subject walk on surface with both feet on the ground. Therapist attempts to perturb patient balance in random fashion and carry object.

3.9 Intervention regimen

Step up

Balance board exercise

Kicking a ball

Stand and walk

Obstacle course

Walk and carry

Stairs

Control group intervention:

Control group was given conventional care according to CRP treatment guideline.

3.11 Method of data collection

The best method for obtaining a participant's full cooperation in a survey is through face-to-face interviews (Fraenkel and Wallen, 2000, p.436). In order for the patients to fully comprehend the questions and provide accurate answers, the questions were occasionally described in the original language, depending on the participants' comprehension ability.

3.12 Data collection Tools

The structured questionnaire used to gather information on related topics was used to ask the interviewer questions. However, there were five sections and a total of 100 questions on the survey. Name, sex, age, education level, height, weight, BMI, and other sociodemographic variables and background information were included in the first section. Items on medical information including stroke kinds, length, hypertension, diabetes mellitus, blood pressure, assistive device, history of experience with falls, etc. were added in the second section. The third segment contained information about balance according to the Berg Balance Scale (BBS).

3.13 Berg Balance Scale (BBS)

The Berg balance scale is used to assess a patient's capability (or incapacity) to balance safely while performing a series of specified tasks. It has 14 items and takes about 20 minutes to complete. Each item has a five-point ordinal scale with a range of 0 to 4, with 0 denoting the lowest degree of function and 4 denoting the highest level of function.

3. 14 Data analysis

Statistical analysis was performed by using statistical package for social science (SPSS) version 22.

3.14.1 Statistical test

According to DePoy and Gitlin (2015), statistical analysis is the systematic, mathematical technique and rules-based organizing and interpretation of data. Mann-Whitney U-test was employed to compare the balance and functional state of the groups. The Wilcoxon signed rank test was used to examine the balance and functional status within groups (Hicks, 2009).

3.14.2 Level of Significance

To find out the significance of the study, the "p" value was calculated. The p values refer to the probability of the results for experimental study. The word probability refers to the accuracy of the findings. The level of significant was set at 95% ($p<0.05$). A p value is called level of significance for an experiment and a p value of <0.05 was accepted as significant result for health service research. If the p value is equal or smaller than the significant level, the results are said to be significant (DePoy and Gitlin, 2015).

3.14.3 Treatment Regimen

Three physiotherapists who were expert in treatment of neurological patient were involved in treatment of patients. All the physiotherapists have the experience of more than three years in the aspect of neurological physiotherapy. Among them, four were male and two were female physiotherapist. Protocol for conventional physiotherapy was obtained from head of physiotherapy department, Centre for the rehabilitation of the paralysed (CRP) (Appendix- F). An in-service training was arranged to share the information with practical demonstration regarding Perturbation-Based Balance Training (PBBT) including patient position, number of task, dose, rest interval and repetition of task (Appendix- A) with conventional physiotherapy.

3.15 Quality control and assurance

The study field and underlying difficulties were thoroughly investigated by the investigator since he had sufficient expertise in the planned investigation. The questionnaire's framework was strictly structural, which made it possible to provide a conclusive response. The questionnaire was created using the results of the literature review. Use a reputable questionnaire that has been peer reviewed and accepted internationally. Due to closely adhered-to inclusion and exclusion criteria, the investigator attempted to avoid selection bias. Conflict over the participant selection was avoided throughout the study.

3.16 Ethical Issues

The study was guided by the supervisor and everything were informed and verified by their guideline. It was also approved by the ethical committee of the IRC, Bangladesh Physiotherapy Association (BPA), Dhaka, Bangladesh. The participants were informed properly and gave consent on consent paper as voluntarily. The participants had absolute rights to withdraw themselves any time and any part of the study. The study ensured the protection of the participants. It also ensured the avoidance of plagiarism.

CHAPTER- IV RESULTS

Participants' demographic and clinical data from a clinical trial are listed in the **table-1**. Two groups, a control and a test, comprised the participants.

The average age of the participants in the control group was 43.13±10.438 years and in the trial group it was 43.40±10.278 years, as shown in the first row of the table. This row also shows that the onset length for all individuals in both groups was between three and six months.

There were 30 people in the control group; 19 (or 63.3% of them) were male and 11 (or 36.7% of them) were female, as seen in the second row. In trial group of 30, 21 (70% male) were enrolled in the trial group, while 9 (30%) were female. Because of this, we may conclude that there was no discernible gender gap between the two sets of participants.

20 subjects (66.7%) from the control group lived in the countryside, whereas 10 subjects (33.3%) resided in the city. 16 (53.3% of the total) of the trial group's 30 people were from rural regions, while 14 (46.7% of the total) were from metropolitan areas.

Ischemic stroke affected 22 (73.3% of the control group) while hemorrhagic stroke affected 8 (26.7%). Twenty (66.7%) of the 30 people in the study group experienced an ischemic stroke, while 10 (33.3%) suffered a hemorrhagic stroke. Out of the 30 people who participated in the experimental group, 2 (6.7%) and 6 (20%) of the control group had a stroke during the 7 days to 3 months preceding the trial. All 24 (80%) people in the control group and 28 (93.3%) people in the trial group had suffered a stroke between three and six months before the study began.

Table 1: Socio-demographic and Clinical status of participants.

	Control Group		Trial Group	
Mean Age (Years ±SD)	43.13	±10.438	43.40	±10.278
Sex (N=60)				
Male n (%)	19	63.3%	21	70%
Female n (%)	11	36.7%	9	30%
Living Area				
Rural n (%)	20	66.7%	16	53.3%
Urban n (%)	10	33.3%	14	46.7%
Type of Stroke				
Ischemic n (%)	22	73.3%	20	66.7%
Hemorrhagic n (%)	8	26.7%	10	33.3%
Duration of onset				
7 days to 3 months	6	20%	2	6.7%
3 months to 6 months	24	80%	28	93.3%

Sex of the populations

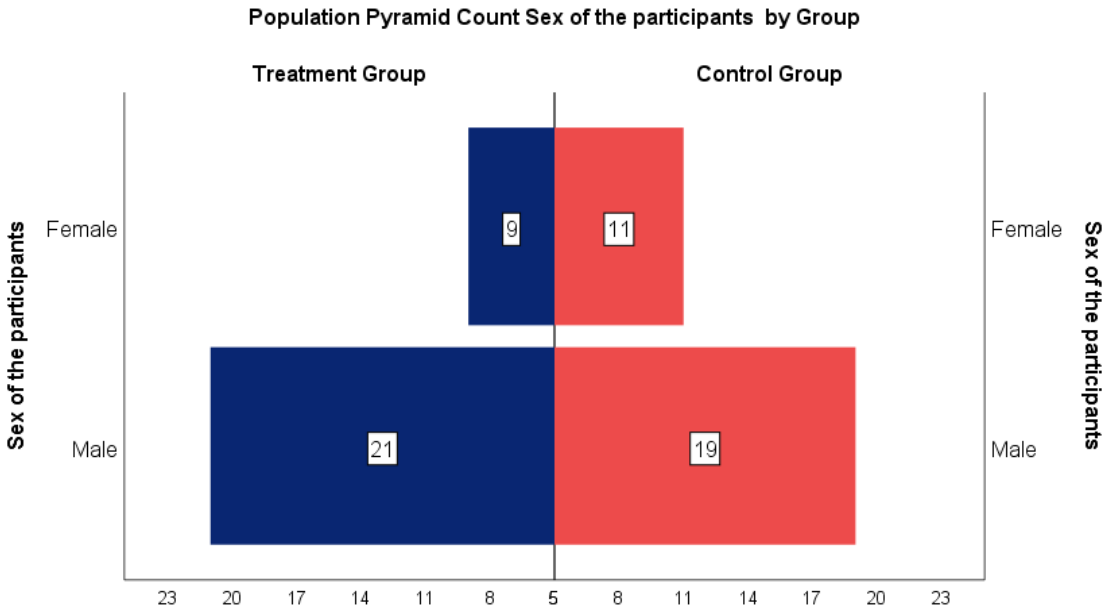

Figure 2: Sex of the populations

As can be seen, there, 19 were male, while 11 were female. The trial group consisted 21 men and 9 women.

Age category

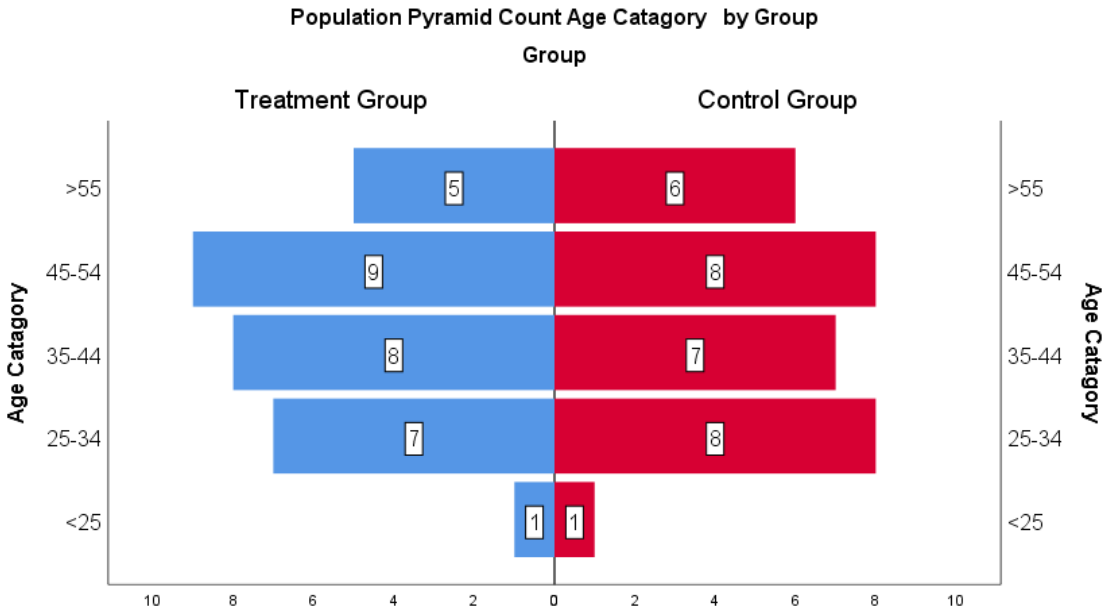

Figure 3: Age category

The number of people in the treatment group who were older than 55 years old was 5, whereas the number of people in the control group who were older than 55 years old was 6. Between the ages of 45 and 54, the treatment group had a prevalence of 9, whereas the control group had a prevalence of 8. In the ages of 35 and 44 was 8 for the treatment group, whereas the age range for the control group was 7 to 34. The ages of 25 and 34 was 6 for the treatment group, whereas the age range for the control group was 8 years. Less than 25 years old received a point for the treatment group while the control group received one point.

Occupation of the participant

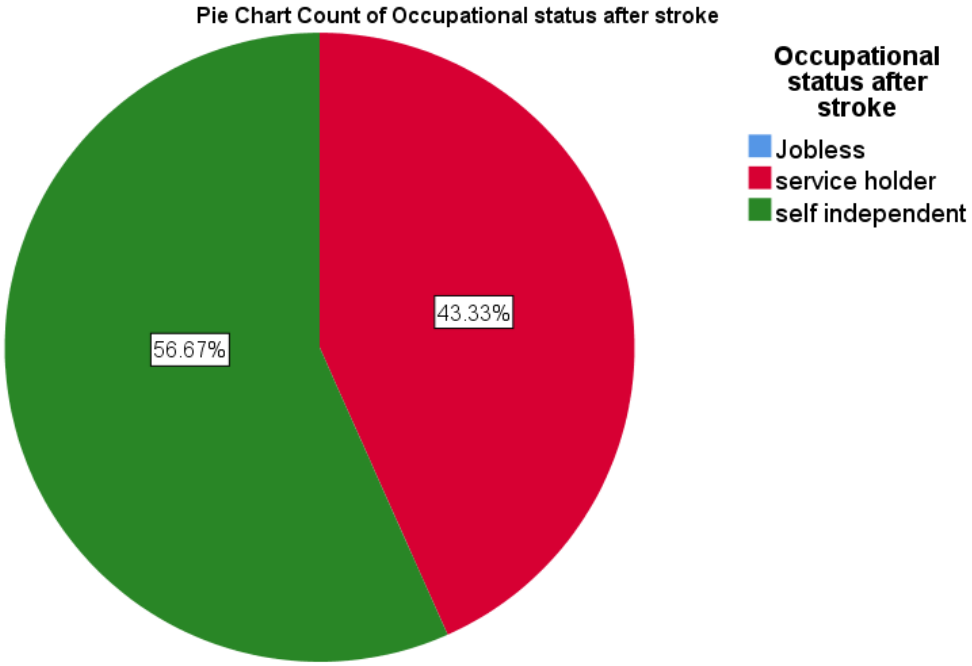

Figure 4 : Occupation of the participant

According to the findings, 56.67 percentage of people belong to the category of "service holder," which indicates that they were working for an organization or corporation in a paid capacity and receiving a wage or other kind of consistent remuneration for their efforts. On the other hand, 43.33% of people were considered to be "self-independent," which means that they were self-employed or their own enterprises and do not work for any other organization. This group of people does not comprise the workforce of any other company.

Mann Whitney U test

Table 2: Mann Whitney U test for between group analysis for total BBS

Difference between Berg Balance Scale	Category of participants	N	Mean of posttest BBS	Mean rank	z	p
	Experimental	30	24.60	37.23	3.312	0.001
	Control	30	26.53	23.77		
	Total	**60**				

Table 2 showed that the calculated value of z is 3.312 for berg balance scale. From the critical value of z for 95% confidence interval, 1.96 which is smaller than calculated value. So, it was clear that Z value between experimental and control groups had an associated probability. The level of significance is 0.001 which is less than 0.05. Therefore, the result was significant for two tailed hypothesis. Since the p value was less than 0.05, the result was significant and the null hypothesis (no relationship) was rejected and the alternative hypothesis was accepted. So, it can conclude that perturbation-based balance training along with usual physiotherapy was more effective than only usual therapy to improve balance for the patients with stroke.

Within group analysis

Table 3: Within group analysis by wilcoxon sign rank test for individual variable of BBS

Variables	Mean of Post-test	SD	Wilcoxon Sign rank test Z	P value
BBS test difference within control group	53.73	2.196	4.79	0.001
BBS test difference within experimental group	55.50	1.075	4.79	0.001

This study found that in berg balance score test observed value was 4.79 in the control group at two tailed Wilcoxon sign rank test while this same variable for experimental group observed value was 4.79. At 95% confidence level the critical value of z was 1.96 which was smaller than the observed z value of both groups. That means null hypothesis was rejected and alternative hypothesis was accepted, that indicated that perturbation-based balance exercise was effective for the patients with stroke. The observed value in control group was greater than the critical z value that means null hypothesis was accepted and alternative hypothesis was rejected. Table showed that within group analysis of perturbation-based balance exercise has highly significant improvement in berg balance test in fact in control group (p= 0.001) and trial group (p= 0.001).

Between group comparison of mean Brag Balance score

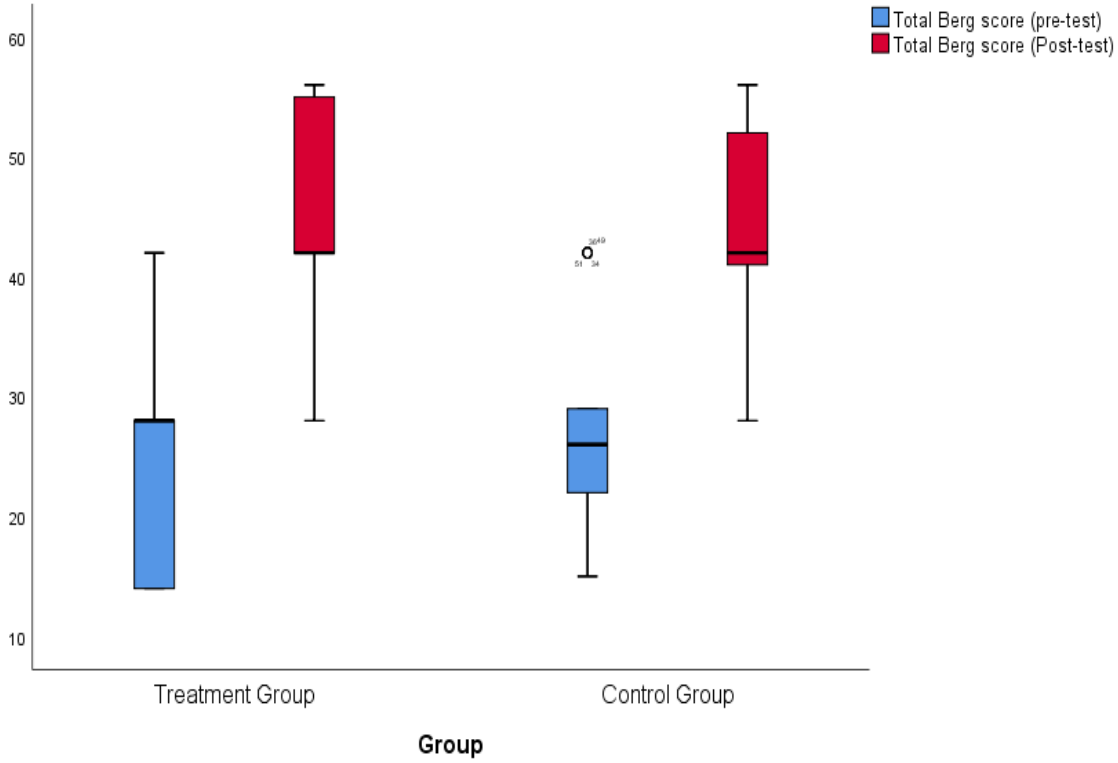

Figure 5: Between group comparison of mean Brag Balance score.

Box plot reveled that there was similarity in average score during pre-test comparison but posttest comparison showed better outcome in treatment groups.

CHAPTER- V DISCUSSION

The current study supports our main hypothesis that PBBT can improve lower limb functional activity in subacute People with Stroke. Participants in the PBBT group showed greater improvements and high effect size in multiple-step threshold in response to forward and backward surface translations as well as significant improvement and moderate effect size in balance scale (BB scale) compared with the conventional tanning group. Both groups improved their fall thresholds as well as balance and gait function (i.e., Brag Balance Scale) with advantage to PBBT versus conventional exercise. Where mean berg balance score was 55.50 for experimental groups and 53.73 for control groups.

Stroke is the biggest cause of permanent disability globally, and it frequently results in difficulties with balance and the use of the lower extremities. It has been suggested that perturbation-based balance training (PBT) may help stroke survivors regain their equilibrium and return to more active lifestyles. Mansoori et al. (2021) conducted a randomized controlled experiment to examine the efficacy of combining PBT with conventional treatment in enhancing functional activity in the lower limbs of stroke survivors. Balance and lower limb functional activity were observed to be improved by PBT in conjunction with conventional therapy more so than by conventional therapy alone.

Mansoori et al. (2021) 's research gives useful information on the possible advantages of PBT for stroke survivors. The study followed the tried-and-true method of determining an intervention's efficacy a randomized controlled trial. A total of 60 people were enrolled in the trial and were split evenly between the PBT and control groups. In addition to their regular therapy, those in the PBT group also participated in 12 sessions of PBT.

PBT has promise as an intervention for enhancing balance and lower limb functional activity in stroke survivors, as evidenced by the findings of the studies by Mansoori et al. (2021) and Wang et al. (2020). PBT, on the other hand, is a difficult and time-consuming intervention that calls for specific tools and knowledgeable therapists.

Hence, more research into the practicability and cost-effectiveness of incorporating PBT into clinical practice is warranted. Kim et al. (2021) 's randomized controlled experiment examined how PBT and conventional treatment affected stroke survivors' lower limb functional activities. PBT and conventional treatment were randomly allocated to 40 individuals in the trial. The experimental group improved lower limb functional activity much more than the control group. Wei et al.(2021) 's systematic review and meta-analysis examined PBT's efficacy in treating stroke survivors. 15 randomized controlled studies involved 885 individuals. The meta-analysis found that PBT improved balance and gait speed in stroke survivors better than other balance training approaches.

An increase in the capacity to adapt to an unexpected loss of balance in everyday circumstances may lead to fewer falls, as suggested by Kim et al. (2021). This result agreed with the results of prior evaluations showing the safety-enhancing effects of PBT for people of all ages and abilities, including those with Parkinson's disease (Mansfield et al., 2015; Nnodim et al., 2018). By comparing gait perturbation training to non-perturbation training in people with Parkinson's disease and healthy older individuals, Hulzinga et al. (2019) observed no statistically significant improvement in balance. While two of the included trials did find a reduction in dropping rates 1 year after PBT, it was not statistically significant. Possible explanations for this disparity include insufficient statistical power due to a too-small sample size (Kim et al., 2021).

The ABC scale assesses a person's fear of falling by testing their assurance that they can keep their balance and grounding while completing a series of practical exercises. As a result, higher scores on the ABC Balance Confidence Scale suggested decreased fear of falling, a significant psychological barrier that may reduce participation in daily activities, function, and fall risk (Li et al., 2020). Previous research found that chronic stroke patients' lack of balance confidence significantly increased their risk of falling (Wang et al., 2021). Yet, compared to control therapies, PBT did not improve balance confidence in any meaningful way (Li et al., 2020).

Although PBT alone may not be enough to significantly improve balancing confidence, combining it with psychological therapies like cognitive behavior therapy (CBT) may have a positive impact. According to previous research, cognitive behavioral therapy (CBT) is a viable adjuvant therapy that can boost the efficacy of physiotherapy in treating the fear of falling (Li et al., 2020). The functional and neurological levels provide potential explanations for the process behind patients' improvement following perturbation training.

Balance recovery from random perturbations is aided by sensory input, which transmits information about the direction and amount of bodily imbalance to guide the selection and scalability of optimal response movements (Mansfield et al., 2015). Furthermore, the enhancement has a neurological basis. Training with repetitive slip-like perturbations during walking led to increased activity in the prefrontal and parietal cortices, as discovered by Patel et al. (2014). The brain regions responsible for selecting and scaling appropriate compensatory movements in response to a given balancing disturbance can be strengthened by perturbation training.

Because of the rapid improvement in the first several weeks following a stroke, the relative plateau around 3 months, and the less meaningful recovery after 6 months, PBT was more effective in patients with subacute stroke than chronic (Kim et al., 2021). Researchers and clinicians interested in employing perturbation training with stroke survivors should, therefore, think about when best to use this intervention.

Wei X. J., Tong K. Y., Hu X. L., and Li L. S. (2021) report that "Although beneficial, PBT in stroke patients lacked a standard protocol, and training methods varied widely across the included studies (some employed PBT alone, while others coupled it with other exercises). In addition, 4 research employed manual perturbation while 3 used device-based perturbation. Classes varied in frequency from 2-6 per week, with programs lasting anywhere from 2.5-10 weeks.

Just four research revealed the average number of disruptions experienced by participants over the whole training period. So, it is necessary to identify the most effective training modality and dose for achieving desired outcomes ".

In the present study we compared PBBT vs Conventional tanning, a training method which was previously identified as a successful balance training and functional recovery for Parson with Stroke (Handelzalts et al., 2019). Both training modes were well-adjusted

in terms of number of repetitions, treatment duration and progression mode and both were adjusted personally according to the highest balance capacity of each participant. This was supported by the similarity in the perceived level of challenge in both groups. In terms of learning, the beneficial effects of PBBT suggest that experiencing errors, which are equivalent to a fall or a near fall in response to surface translations, may implicitly accelerate re-learning of strategies for balance control and functional independency.

Several limitations of the study should be acknowledged. First, the results are based on a fairly small sample that was drawn from subacute Person with Stroke with a moderate/high level of function (i.e., able to walk independently or under supervision), a fact that limits generalization of the conclusions to more severely affected Person with Stroke. Thus, one can argue that improved balance recovery responses in these measurements may reflect task familiarity. Yet it should be noted that in earlier PBBT studies in older adults, improvement in balance recovery capacity in the laboratory was shown to generalize and relate to reduced falls in real life. This highlights the fourth limitation, we did (Handelzalts et., al. 2019) not monitor falls prospectively. Consequently, based on the current results we cannot assert with confidence that improvements in reactive balance behavior after PBBT shown in the laboratory predict reduced fall rate in real-life conditions. These limitations should be taken into considerations when designing further clinical trials testing PBBT. In conclusion, our results show that reactive balance responses and balance confidence can be improved through PBBT. The results support conducting reactive balance training during rehabilitation of Person with Stroke.

CHAPTER- VII CONCLUSION

In conclusion, this randomized controlled study demonstrates that perturbation-based balance training, when added to standard therapy, can be an effective intervention for enhancing lower limb functional activity in stroke survivors. Those who completed perturbation-based balance training outperformed those who only got standard treatment on tests of balance, gait speed, and lower limb strength. Our findings imply that include perturbation-based balance training in rehabilitation programs may improve outcomes for patients with stroke, which has substantial implications for stroke rehabilitation. Long-term benefits on functional outcomes, as well as the ideal dosage and timing of perturbation-based balance training, require more study.

CHAPTER- VI I REFERENCE

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APPENDIX

CONSENT FORM

(Please read out to the participants)

Assalamualaikum,

I am Nazmun Nahar, I am conducting this study for a M. Sc in Physiotherapy project study dissertation titled **"Effects of Perturbation-Based Balance Training along with usual therapy for improving lower limb functional activity for people who experienced a stroke"** under Bangladesh Health Professions Institute (BHPI), University of Dhaka. I would like to know about some personal and other related information regarding after Spinal cord injury functional abilities and community integration. You will perform some tasks which are mention in this form. This will take approximately 30-40 minutes.

I would like to inform you that this is a purely academic study and will not be used for any other purpose. The researcher is not directly related with this Spinal cord injury area, so your participation in the research will have no impact on your present or future treatment in this area (Spinal cord injury unit). All information provided by you will be treated as confidential and in the event of any report or publication it will be ensured that the source of information remains anonymous and also all information will be destroyed after completion of the study. Your participation in this study is voluntary and you may withdraw yourself at any time during this study without any negative consequences. You also have the right not to answer a particular question that you don't like or do not want to answer during interview.

If you have any query about the study or your right as a participant, you may contact with me, researcher and/or with my supervisor Ehsanur Rahman, Associate Professor, department of physiotherapy, CRP, Savar, Dhaka. Do you have any questions before I start?

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

Yes ☐

No ☐

Signature of the Participant _____

Signature of the Interviewer _____

Signature of the Witness _____

Effects of Perturbation-Based Balance Training along with usual therapy for improving lower limb functional activity for people who experienced a stroke

Patient name:	**Patient ID No:**
Address: **Village:** **Union:**	
Mobile no:	
Name of assessor and date:	

Socio-demographic and clinical information

(Put ✓ mark on answer)

<table>
<tr><td>Age</td><td colspan="2"></td><td>Stroke type</td><td>Ischemic stroke = 1
Hemorrhagic stroke = 2</td></tr>
<tr><td>Gender</td><td colspan="2">Male = 1
Female = 2</td><td>Date of incident</td><td></td></tr>
<tr><td>Living area</td><td colspan="2">Urban = 1
Semi-urban = 2
Rural = 3</td><td>Chronicity</td><td>Acute (1 to 7 days) = 1
Early sub-acute (7 days to 3 months) = 2
Late sub-acute (3 to 6 months) = 3
Chronic (> 6 months) = 4</td></tr>
<tr><td>Education</td><td colspan="2">No formal education = 1
Primary education = 2
SSC pass = 3
HSC pass = 4
Bachelor and above = 5</td><td>Affected hemisphere</td><td>CVA with LSH = 1
CVA with RSH = 2</td></tr>
<tr><td rowspan="2">Occupation</td><td>Before stroke</td><td>After stroke</td><td rowspan="2">Sensory impairment</td><td rowspan="2">Intact = 1
Impaired = 2
Loss = 3</td></tr>
<tr><td>Unemployed = 1
Waged employed = 2
Self-employed = 3</td><td>Unemployed = 1
Waged employed = 2
Self-employed = 3</td></tr>
<tr><td>Monthly family income</td><td colspan="2"></td><td>Pain status (Use NPR scale)</td><td>Mild pain = 1
Moderate pain = 2
Severe pain = 3</td></tr>
<tr><td colspan="3">Number of family members</td><td>Can do normal activities</td><td>As like before = 1
Not like before = 2
Cannot do anything = 3</td></tr>
<tr><td colspan="3">Number of adult members</td><td colspan="2"></td></tr>
<tr><td colspan="3">Number of earning members</td><td colspan="2"></td></tr>
</table>

SECTION-3: Assessment of balance

No.	Test	Pre test	Post test
3.1	**SITTING TO STANDING:***(Please stand up. Try not to use yourhand 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		
3.2	**STANDING UNSUPPORTED:** *(Please stand for two minuteswithout 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		
3.3	**SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL: (***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		
3.4	**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		

No.	Test	Pre test	Post test
3.5	**TRANSFERS:** *(Arrange chair for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way towarda 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 hands (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		
3.6	**STANDING UNSUPPORTED WITH EYES 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		
3.7	**STANDING UNSUPPORTED WITH FEET TOGETHER:** *(Place your feet together and stand without holding on)* (4) able to place feet together independently and stand 1 minutesafely (3) able to place feet together independently and stand 1 minutewith supervision (2) able to place feet together independently but unable to hold for30 seconds (1) needs help to attain position but able to stand 15 seconds feettogether (0) needs help to attain position and unable to hold for 15 seconds		

No.	Test	Pre test	Post test
3.8	**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		
3.9	**PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION:** *(Pick up the shoe/slipper, which isplace 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 keepsbalance independently (1) unable to pick up and needs supervision while trying (0) unable to try/needs assist to keep from losing balance or falling		

No.	Test	Pre test	Post test
3.10	**TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS 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		
3.11	**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		
3.12	**PLACE ALTERNATE FOOT ON STEP OR STOOL 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 in20 seconds (3) able to stand independently and complete 8 steps in > 20seconds (2) able to complete 4 steps without aid with supervision (1) able to complete > 2 steps need minimal assist (0) needs assistance to keep from falling / unable to try		

No.	Test	Pre test	Post test
3.13	**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		
3.14	**2.14 STANDING ON ONE LEG:** *(Stand on one leg as long asyou 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 standingindependently (0) unable to try of needs assist to prevent fall		
	Total Berg Balance Score		

সম্মতি পত্র

(অংশগ্রহনকারীকে পড়ে শোনাতে হবে)

আসালামুআলাইকুম/নমস্কার,

আমি নাজমুন নাহার মুন্না, আমি এই গবেষণা প্রকল্পটি বাংলাদেশ হেলথ প্রফেসন ইনস্টিটিউট (বি এইচ পি আই) এ পরিচালনা করছি যা আমার মাস্টার অব সাইন্স ইন ফিজিওথেরাপি কোর্সের অধিভুক্ত। আমার গবেষণার শিরোনাম **"স্ট্রোকের সম্মুখীন হওয়া লোকদের জন্য নিম্ন অঙ্গের কার্যকলাপের উন্নতির জন্য স্বাভাবিক থেরাপির সাথে পারটুর্বেশন- ভিত্তিক ব্যালেন্স প্রশিক্ষণের প্রভাব"** আমি এক্ষেত্রে আপনার কিছু ব্যক্তিগত এবং আনুষাঙ্গিক প্রশ্ন মেরুরজ্জ ক্ষতিগ্রস্থ হওয়ার পর কার্যক্ষমতা ও সম্প্রদায়িক অংশগ্রহণ সম্পর্কে করতে চাচ্ছি। এতে আনুমানিক ৩০-৪০ মিনিট সময় নিবো।

আমি আপনাকে অনুগত করছি যে,এটা আমার অধ্যয়নের অংশ এবং যা অন্যকোন উদ্দেশ্যে ব্যবহার হবে না।গবেষক সরাসরি এই স্নায়ুজ্ঞান অধ্যায়নের সাথে অন্তর্ভুক্ত নয়।তাই এই গবেষনায় আপনার অংশগ্রহণ বর্তমান ও ভবিষ্যৎ চিকিৎসায় কোন প্রকার প্রভাব ফেলবেনা। আপনি যে সব তথ্য প্রদান করবেন তার গোপনীয়তা বজায় থাকবে এবং আপনার প্রতিবেদনের ঘটনা প্রবাহে এটা নিশ্চিত করা হবে যে এই তথ্যের উৎস অপ্রকাষিত থাকবে।

এই অধ্যয়নে আপনার অংশগ্রহন স্বেচ্ছাপ্রণোদীত এবং আপনি যে কোন সময় এই অধ্যয়ন থেকে কোন নেতিবাচক ফলাফল ছাড়াই নিজেকে প্রত্যাহার করতে পারবেন। এছাড়াও কোন নির্দিষ্ট প্রশ্ন অপছন্দ হলে উত্তর না দেয়ার এবং সাক্ষাৎকারের সময় কোন উত্তর না দিতে চাওয়ার অধিকারও আপনার আছে।

এই অধ্যয়নে অংশগ্রহণকারী হিসেবে যদি আপনার কোন প্রশ্ন থাকে তাহলে আপনি আমাকে অথবা /এবং এহসানুর রহমান , সহোযোগী অধ্যাপক, ফিজিওথেরাপি বিভাগ ,সিআরপি, সাভার ,ঢাকা-১৩৪৩-তে যোগাযোগ করতে পারেন।

সাক্ষাৎকার শুরু করার আগে আপনার কি কোন প্রশ্ন আছে?

আমি আপনার অনুনতি নিয়ে এই সাক্ষাৎকার শুরু করতে যাচ্ছি।

হ্যাঁ... ☐

না... ☐

১। অংশগ্রহনকারীর স্বাক্ষর.....।

২।সাক্ষাৎগ্রহনকারীর স্বাক্ষর.....।

৩।সাক্ষীর স্বাক্ষর.....।

স্ট্রোকের সম্মুখীন হওয়া লোকদের জন্য নিম্ন অঙ্গের কার্যকলাপের উন্নতির জন্য স্বাভাবিক থেরাপির সাথে পারটুর্বেশন- ভিত্তিক ব্যালেন্স প্রশিক্ষণের প্রভাব

রোগীর নামঃ	**রোগীর আইডি নংঃ**
ঠিকানাঃ- **গ্রামঃ** **ইউনিয়নঃ**	
মোবাইল নাম্বারঃ	
তথ্য সংগ্রহকারীর নাম ও তারিখঃ	

সামাজিক-জনসংখ্যাগত এবং রোগ বিষয়ক তথ্যাবলি

(সঠিক উত্তরে ✓ চিহ্ন দিন)

বয়স			**স্ট্রোকের ধরণ**	○ ইস্কেমিক স্ট্রোক = **১** ○ হ্যামোরেজিক স্ট্রোক = ২
লিঙ্গ	○ পুরুষ = **১** ○ মহিলা = ২		**স্ট্রোকের তারিখ**	
বসবাসের জায়গা	○ শহর = **১** ○ উপ-শহর = ২ ○ গ্রাম = ৩		**সময়কাল**	○ খুব অল্প কয়েকদিন যাবত (**১** থেকে ৭ দিন) = **১** ○ মোটামুটি কিছুদিন যাবত (৭ দিন থেকে ৩ মাস) = ২ ○ বেশি অল্প দিন ও না বেশি দীর্ঘ দিন ও না (৩ থেকে ৬ মাস) = ৩ ○ দীর্ঘ দিন যাবত (> ৬ মাস) = ৪
শিক্ষাগত যোগ্যতা	○ আনুষ্ঠানিক শিক্ষা নেই = **১** ○ প্রাথমিক শিক্ষা = ২ ○ এস এস সি পাশ = ৩ ○ এইচ এস সি পাশ = ৪ ○ স্নাতক এবং এর উপরে = ৫		**অবশ হওয়া পাশ**	○ শরীরের ডান পাশ = **১** ○ শরীরের বাম পাশ = ২
পেশা	**স্ট্রোকের আগে**	**স্ট্রোকের পরে**		○ পুরোপুরি ভালো = **১**

	○ বেকার = ১ ○ বেতনভুক্ত চাকুরিজীবী = ২ ○ স্বনির্ভরশীল = ৩	○ বেকার = ১ ○ বেতনভুক্ত চাকুরিজীবী = ২ ○ স্বনির্ভরশীল = ৩	**অনুভূতির সমস্যা**	○ ঠিকমতো বোঝে না = ২ ○ কোন অনুভুতি নেই = ৩
			ব্যথার তীব্রতা	○ অল্প কিছুটা = ১ ○ মাঝারী ধরণের = ২ ○ প্রচন্ড ব্যথা = ৩ ○ কোন ব্যথা নাই = ৪
মাসিক পারিবারিক আয়			**স্বাভাবিক কাজ কর্ম করতে পারে?**	○ আগের মতোই = ১ ○ আগের মতো পারে না = ২ ○ কিছুই পারে না = ৩

আপনার পরিবারের সদস্যসংখ্যা কতজন?	
পরিবারে প্রাপ্তবয়স্ক সদস্য কত জন? (বয়স ১৮ এর বেশি)	
পরিবারে উপার্জনকারী সদস্য কত জন?	

বার্গ ব্যালেন্স/ ভারসাম্য স্কেল

অংশ- ৩ ব্যালেন্স সম্পর্কিত তথ্যঃ

সাধারণ নির্দেশনা

প্রতিটি নির্দেশনার জন্য সর্বনিম্ন প্রতিক্রিয়া / চিহ্নের মাধ্যমে সংরক্ষন করা হয়।

SN	প্রশ্ন / নির্দেশনা	প্রতিক্রিয়া
২.১	বসা থেকে দাঁড়ানো (দয়া করে দাঁড়ান। সহায়তার জন্য আপনার হাত ব্যাবহার করার চেষ্টা করবেন না)	৪- হাতের সাহায্য ছাড়া দাঁড়াতে পারে এবং ভারসাম্য রক্ষা করতে পারে। ৩- হাতের সাহায্য নিয়ে নিজে নিজে দাঁড়াতে পারে । ২- হাতের সাহায্য নিয়ে কয়েকবার চেষ্টার পর দাঁড়াতে পারে। ১- দাঁড়াতে অথবা ভারসাম্য রক্ষা করতে নুন্যতম সহযোগিতা লাগে। ০-দাঁড়াতে মোটামুটি অথবা সম্পূর্ন সহযোগিতা লাগে ।
২.২	অবলম্বন ছাড়া দাঁড়ানো (অনুগ্রহপূর্বক কোন কিছুর সাহায্য ছাড়া ২ মিনিট দাঁড়ান)	৪- নিরাপদভাবে ২ মিনিট দাড়াতে পারেন। ৩- পর্যবেক্ষণসহ ২ মিনিট দাঁড়াতে পারে ২- অবলম্বন ছাড়া ৩০ সেকেন্ড দাঁড়াতে পারে । ১- কয়েকবার চেষ্টার পর অবলম্বন ছাড়া ৩০ সেকেন্ড দাঁড়াতে পারে।

২.৩	পিঠে অবলম্বন ছাড়া কিন্তু মেঝে অথবা টুল দিয়ে পায়ে অবলম্বনের সাহায্যে বসা (অনুগ্রহপূর্বক হাত ভাঁজ করে ২ মিনিট বসুন)	৪- নিরাপদভাবে ২ মিনিট বসতে পারে। ৩- পর্যবেক্ষণসহ ২ মিনিট বসতে পারে। ২- ২-৩০ সেকেন্ড বসে থাকতে পারে। ১- ১-১০ সেকেন্ড বসে থাকতে পারে। ০- অবলম্বন ছাড়া ১০ সেকেন্ড বসে থাকতে অক্ষম।
২.৪	দাঁড়ানো থেকে বসা (অনুগ্রহপূর্বক বসুন)	৪- নুন্যতম হাতের সাহায্য দ্বারা নিরাপদে বসতে পারে । ৩- হাতের সাহায্য দ্বারা বসতে পারে। ২-ভারসাম্য রক্ষার জন্য চেয়ারের সাথে পা ব্যবহার করে । ১-নিজে নিজে ভারসাম্যহিণভাবে বসতে পারে। ০-বসতে সাহায্যকারীর প্রয়োজন হয়।
২.৫	স্থানান্তর (অনুগ্রহপূর্বক হাতে ভর দিয়ে চেয়ারের একদিকে এবং ভর ছাড়া অন্যদিকে স্থানান্তর হতে চেষ্টা করুন)	৪-নুন্যতম হাতের সাহায্য দ্বারা নিরাপদে স্থানান্তর হতে পারে । ৩- হাতের সাহায্য দ্বারা নিরাপদে স্থানাত্মর হতে পারে । ২-মৌখিক নির্দেশনা অথবা পর্যবেক্ষনের মাধ্যমে স্থানান্তর হতে পারে। ১-একজন সাহায্যকারীর প্রয়োজন হয়। ০- দুইজন সাহায্যকারীর প্রয়োজন হয়

২.৬	অবলম্বন ছাড়া চোখ বন্ধ অবস্থায় দাঁড়ানো (অনুগ্রহপূর্বক চোখ বন্ধ করুন এবং ১০ সেকেন্ড দাঁড়ান।)	৪- ১০ সেকেন্ড নিরাপদে দাঁড়াতে পারে । ৩- পর্যবেক্ষণের মাধ্যমে ১০ সেকেন্ড নিরাপদে দাঁড়াতে পারে । ২- ৩ সেকেন্ড দাঁড়াতে পারে । ১- ৩ সেকেন্ড চোখ বন্ধ রাখতে পারে না কিন্তু দাঁড়াতে পারে । ০- পড়ে যাওয়া রোধ করতে সাহায্যের প্রয়োজন ।
২.৭	দুই পা একত্র করে অবলম্বনহীভাবে দাঁড়ান (অনুগ্রহপূর্বক দুই পা একত্র করে কোন সাহায্য ছাড়া দাঁড়ান)	৪-দুই পা একত্র করে স্বাধীনভাবে ১ মিনিট দাঁড়াতে পারে । ৩-পর্যবেক্ষণসহ দুই পা একত্র করে স্বাধীনভাবে ১ মিনিট দাঁড়াতে পারে। ২-দুই পা একত্র করে দাঁড়াতে পারে তবে ৩০ সেকেন্ড এর কম । ১-দাঁড়াতে সাহায্যের প্রয়োজন হয় কিন্তু ১৫ সেকেন্ড পা একত্র করে রাখতে পারে । ০-দাঁড়াতে সাহায্যের প্রয়োজন হয় এবং ১৫ সেকেন্ড পা একত্র করে রাখতে পারে না।

২.৮	দাঁড়ানো অবস্থায় দুইহাত উঁচু করে সামনের দিকে ঝুঁকা (দুই হাত ৯০ ডিগ্রি উঁচু করবেন । আঙ্গুল সোজা রেখে যতটা সম্ভব সামনে ঝুঁকুন)	৪- সঠিকভাবে ২৫ সে.মি. সামনে যেতে পারে । ৩- সঠিকভাবে ১২ সে.মি. সামনে যেতে পারে । ২- সঠিকভাবে ৫ সে.মি. সামনে যেতে পারে। ১-সামনে যেতে পারে কিন্তু পর্যবেক্ষনের প্রয়োজন হয় । ০-ভারসাম্য হারিয়ে ফেলে অথবা অন্যের সহায়তা লাগে ।
২.৯	দাঁড়ানো অবস্থায় মেঝে থেকেকোন বস্তু তোলা (মেঝেতে আপনার পায়ের সামনে রাখা জুতাটি তুলুন)	৪-সহজে এবং নিরাপদে জুতাটি তুলতে পারে। ৩-জুতা তুলতে পারে কিন্তু পর্যবেক্ষন প্রয়োজন হয় । ২-জুতার ২-৫ সেমি পর্যন্ত যেতে পারে কিন্তু তুলতে পারে না তবে ভারসাম্য রক্ষা করতে পারে । ১-জুতা তুলতে পাওে না এবং চেষ্টার সময় পর্যবেক্ষণ প্রয়োজন হয়। ০-চেষ্টা করতে পারেনা অথবা ভারসাম্য রক্ষার জন্য সাহায্যকারী প্রয়োজন হয়।

২.১০	দাঁড়ানো অবস্থায় ডান এবং বাম কাঁধ দিয়ে পিছনে তাকানো।	৪-দুই দিকেই ঘুরতে পারে এবং সমানভাবে ভর দেয়। ৩-শুধুমাত্র একদিকে ঘুরতে পারে এবং অন্যদিকে কম ভর দেয়। ২- শুধুমাত্র পাশ ঘোরা কিন্তু ভারসাম্য বজায় রাখে। ১- ঘোরার সময় তত্বাবধানের প্রয়োজন হয়। ০- ভারসাম্য হারানো বা পতন থেকে রক্ষা করতে সাহায্যের প্রয়োজন হয়
২.১১	৩৬০ ডিগ্রি ঘুরা(পুরোপুরি বৃত্তাকারে ঘুরে দাড়ান। থামুন। আবার অন্যদিকে পুরোপরি বৃত্তাকারে ঘুরে দাড়ান।)	৪ - ৪ সেকেন্ডা বা তার কম সময়ে ৩৬০ ডিগ্রিতে ঘুরে দাড়াতে সক্ষম। ৩- ৪ সেকেন্ড বা তার কম সময়ে এক পাশে ৩৬০ ডিগ্রি ঘুরে দাড়াতে সক্ষম। ২- নিরাপদে কিন্তু ধীরে ধীরে ৩৬০ ডিগ্র ঘুরে দাড়াতে সক্ষম । ১- নিবিড় পর্যবেক্ষন বা মৌখিক কিউইং দরকার হয়। ০- ঘুরার সময় সাহায্যের প্রয়োজন হয়।

২.১২	দাঁড়িয়ে থাকা অবস্থায় অন্য পায়ের পাতাটি একটি ধাপে বা টুলে রাখুন (প্রতিটি পায়ের পাতা বিকল্পভাবে কোন ধাপে বা টুলে রাখুন। প্রতিটি পায়ের পাতা কোন ধাপ বা টুলকে ৪ বার না ছোয়া পর্যন্ত প্রক্রিয়াটি চালু থাকবে)	৪- স্বাধীন ও নিরাপদভাবে দাড়াতে সক্ষম এবং ৮ টি ধাপ ২০ সেকেন্ডে সম্পন্ন করতে পারে। ৩- স্বাধীনভাবে দাড়াতে সক্ষম এবং ২০ সেকেন্ডের মধ্যে ৮ টি ধাপ সম্পন্ন করতে পারে। ২- তত্বাবধানে মাধ্যমে সাহায্য ছাড়াই ৪ টি ধাপ সম্পন্ন করতে পারে। ১- নুন্যতম সহায়তার মাধ্যমে ২ টি ধাপের বেশি সম্পন্ন করতে পারে। ০- পতন থেকে রক্ষা করার জন্য সহায়তা প্রয়োজন / চেষ্টা করতে অক্ষম।
২.১৩	অসমর্থনভাবে দাঁড়ানো অবস্থায় ধাপে বা টুলে বিকল্প পা রাখুন (এক পা সরাসরি অন্য পায়ের সামনে রাখুন। আপনি যদি মনে করেন যে আপনি আপনার পা সরাসরি সামনে রাখতে পারবেন না, তবে আপনার সামনের পায়ের গোড়ালিটি অন্য পায়ের আঙ্গুলের চেয়ে এগিয়ে নেয়ার চেষ্টা করুন।	৪- স্বাধীনভাবে ফুট টেন্ডেম স্থাপন করতে এবং ৩০ সেকেন্ড ধরে রাখতে সক্ষম। ৩- স্বাধীনভাবে পা এগিয়ে রাখতে এবং ৩০ সেকেন্ড ধরে রাখতে সক্ষম। ২- স্বাধীনভাবে ছোট স্টেপ নিতে এবং ৩০ সেকেন্ড ধরে রাখতে সক্ষম। ১- স্টেপ নিতে সাহায্যর প্রয়োজন কিন্তু ১৫ সেকেন্ড ধরে রাখতে পারে। ০- পা ফেলা বা দাঁড়ানোর সময় ভারসাম্য হারায়।

২.১৪	এক পায়ে দাঁড়ানো (অবলম্বন ছাড়া যতক্ষন সম্ভব।এক পায়ে দাঁড়ানো)	৪-নিজে নিজে পা তুলতে পারে এবং ১০ সেকেন্ড এর বেশি সময় থাকতে পারে। ৩- নিজে নিজে পা তুলতে পারে এবং ৫-১০ সেকেন্ড থাকতে পারে। ২-নিজে নিজে পা তুলতে পারে এবং ৩ সেকেন্ড বা কম থাকতে পারে। ১-পা তুলতে চেষ্টা করে কিন্তু ৩ সেকেন্ড রাখতে পারে না তবে নিজে নিজে দাঁড়াতে পারে । ০-চেষ্টা করতে পারেনা এবং পড়ে যাওয়া রোধে সাহায্যের প্রয়োজন।

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

Ref: CRP/BHPI/IRB/10/2022/665

Date: 25/10/2022

To
Nazmun Nahar Munna
M.Sc. in Physiotherapy
Session: 2020-2021, DU Reg No. : 3053
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Subject: Approval of the thesis proposal **"Effects of Perturbation-Based Balance Training along with usual therapy for improving lower limb functional activity for people who experienced a stroke"** by ethics committee.

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

Sr. No.	Name of the Documents
1	Dissertation Proposal
2	Questionnaire (English version)
3	Information sheet & consent form.

The purpose of the study is to determine the effects of Perturbation-Based Balance Training (PBBT) along with usual therapy for improving lower limb functional activity for people who experienced a stroke. Should there any interpretation, typo, spelling, and grammatical mistake in the title, it is the responsibility of investigator. Since the study involve questionnaire that may take 25 to 30 minutes and have no likelihood of any harm to the participants. Data collector will receive informed consents from all participants, The members of the Ethics committee approved the study to be conducted in the presented form at the meeting held at 09.00 AM on 24th September 2022 at BHPI.

The institutional Ethics committee expects to be informed about the progress of the study, any changes occurring during the study, any revision in the protocol and 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, Dept. of Rehabilitation Science
Member Secretary, Institutional Review Board (IRB)
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

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Ref: *Date:*

Treatment protocol for stroke Patient

Neurology Unit, CRP, Savar

PT Rx:

- Positioning maintain in any starting position.
- Stabilization of the pelvic girdle, knees and shoulder girdle 10 mins
- Sensory stimulation of U/L 5 mins and L/L 5 mins
- Proprioceptive exercise of U/L 10 mins and L/L 10 mins
- CHOR practice 10 mins
- Body schema exercise 10 mins
- Scapular setting exercise 10 mins
- Proximal stability exercise 10 mins
- Selective mvt practice of U/L 10 repetition separately, L/L repetition separately.
- Midline orientation exercise 10 mins
- Bobath trunk mob 10 mins, pelvic girdle mob 10 mins and shoulder girdle mob 10 mins
- Bobath hand mob 10 mins and foot mob10 mins.
- Selective mvt practice/ Functional strengthening of U/L 10-20 reps and L/L 10-20 reps
- Coordination practice in formative way 10 min/session
- Core strengthening per set of exercise 10 reps.
- PNF stretching 10 rep each diagonal movement
- STS practice 10 reps
- Dynamic sitting/ standing balance 10-20 mins
- Stepping practice 10 mins
- SPG/ CPG practice 10 mins
- Gait reeducation 10-20 mins
- Stair up and stair down practice 10 mins
- Electrotherapy (TENS/ Tropic stimulator) 10-15 mins

Gym activity: CPM 5-10 min, ET 10 rep, SR 10 rep, Cycling 5 mins, Hamstring/ Coards strengthening 5-15 kg/10 reps, Leg press 10-20 reps, Static runner 5-10 mins, Chest or Shoulder Press 10-15 reps, Hand cycling 5-10 mins.

Rashid 31.05.23
Harun-Or-Rashid
Consultant & In-charge
Neurology Unit, Physiotherapy Dept.
CRP, Savar, Dhaka

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