



Faculty of Medicine  
University of Dhaka

## **Effectiveness of Proprioceptive Neuromuscular Facilitation on Balance and Muscle Tone in Stroke Patients: A Randomized Controlled Trial**

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## **DECLARATION**

This work has not previously been accepted in substance for any degree and isn't concurrently submitted in candidature for any degree. This dissertation is being submitted in partial fulfillment of the requirements for the degree of B.Sc. in Physiotherapy.

I confirm that if anything identified in my work that I have done plagiarism or any form of cheating will directly be awarded a fail and I am subject to disciplinary actions of authority. I confirm that the electronic copy is identical to the bound copy of the Thesis. In case of dissemination of the finding of this project for future publication, the research supervisor will be highly concerned, it will be duly acknowledged as a graduate thesis and consent will consent taken from the physiotherapy department of Saic College of Medical Science & Technology (SCMST)

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## **Acronyms**

**ADLs** - Activities of Daily Living

**BBS** - Berg Balance Scale

**BMRC** - Bangladesh Medical Research Council

**CNS** - Central Nervous System

**MAS** - Modified Ashworth Scale

**PNF** - Proprioceptive Neuromuscular Facilitation

**RCT** - Randomized Controlled Trial

**SCMST** - Saic College of Medical Science and Technology

**SPSS** - Statistical Package for the Social Sciences

**WHO** - World Health Organization

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## Abstract

**Purpose:** The aim of this study was to evaluate the effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) combined with conventional physiotherapy in improving balance and muscle tone among stroke patients in Dhaka. **Objective:** To assess the impact of PNF on balance and spasticity reduction in stroke rehabilitation. **Methodology:** This single-blind randomized controlled trial was conducted from April 2023 to July 2023 at two physiotherapy centers in Dhaka. Twenty stroke patients who met the inclusion and exclusion criteria were randomly allocated into two groups: 10 participants in the experimental group receiving PNF with conventional physiotherapy and 10 in the control group receiving only conventional physiotherapy. Participants underwent 12 sessions of treatment over four weeks. The Berg Balance Scale (BBS) was used to assess balance, and the Modified Ashworth Scale (MAS) was used to measure spasticity. Statistical analyses were performed using SPSS version 25.0, employing the Wilcoxon signed-rank test for inferential analysis. **Results:** The experimental group demonstrated significant improvements in both balance and muscle tone compared to the control group. The mean BBS score in the experimental group increased from  $34.09 \pm 1.81$  to  $48.00 \pm 1.54$ , with a mean difference of 13.91 ( $p < 0.05$ ). The MAS scores revealed a greater reduction in spasticity across all muscle groups in the experimental group compared to the control group. **Conclusion:** PNF was found to be effective in improving balance and reducing spasticity in stroke rehabilitation. While the findings are promising, the study was limited by a small sample size and short duration. Future research should incorporate larger sample sizes and explore the long-term effects of PNF using a double-blind randomized controlled trial design.

**Keywords:** *Stroke, Proprioceptive Neuromuscular Facilitation, Berg Balance Scale, Modified Ashworth Scale, Physiotherapy.*

## 1.1 Background

Stroke is a major public health problem globally, and one of the most common causes of disability and death worldwide. Stroke is a leading cause of disability, with millions of people impacted each year, and often leads to long-term disabilities that affect motor function, balance, and muscle tone (Saini et al. 2021, p. 56). Chronic physical impairments after stroke are common, affecting survivor's quality of life and ability to engage in activities of daily living and independence (Murphy et al. 2020, p. 561). The main pillars of post-stroke rehabilitation strategies are based in recovering motor control, alleviating muscle spasticity, and improving balance to avoid falls and further complications (George et al. 2017, p. 695). One of those interventions which have been highly researched and utilized in the settings of stroke rehabilitation is Proprioceptive Neuromuscular Facilitation (PNF), a technique utilized to improve neuromuscular control and functional movement patterns (Chaturvedi et al. 2018, p. 391).

Stroke typically causes deficits in both postural control and muscle tone regulation needed for mobility and independence (Victoria et al. 2013, p. 623). Muscle tone abnormalities including spasticity or hypotonia cause movement dysfunction and increased fall risk in stroke survivors. Postural instability is the next most significant impairment, where many patients demonstrate asymmetric weight bearing, poor proprioception, and decreased motor coordination (Kim et al. 2019, p. 213). These deficits impair ambulation, stair climbing, and overall mobility, and require active interventions aiming to reestablish muscle tone and balance (Guiu-Tula et al. 2017, p. 1).

PNF techniques are designed to help reduce these problems through determined movement patterns, resistance training, and proprioceptive input to improve neuromuscular coordination (Nguyen et al. 2022, p. 882). PNF works by stretching, resistance and rhythmic movement to stimulate the neuromuscular system and improve motor function, balance and flexibility (Pachruddin et al. 2020, p. 32033).

PNF is a approach that improves motor recovery where the sensory receptors in the muscles and joints are intensively excited by stretching, resistance (isometric) and

verbal direction (Chaturvedi et al. 2018, p. 391). This technique was first created by Dr. Herman Kabat and Margaret Knott in the 1940s as a way to treat patients struggling with neuromuscular disorders and has since taken on a prominent role in stroke rehabilitation (Victoria et al. 2013, p. 623). PNF consist of spiral, diagonal movement patterns, that more closely represent natural functional movements of the body and motor learning (Kim et al. 2019, p. 213).

Several studies showed that PNF based intervention significantly improve balance, muscle strength, and gait performance in the post stroke subjects. Nguyen et al (2022, p. 882) performed a meta analysis that all of the PNF exercises produce significant improvements in BBS, TUG, and FRT, all three of which are critical assessments of postural control. In addition, the supportive properties of water allow for PNF techniques within an aquatic environment to promote greater movement efficiency and reduced muscle tone (Kim et al. 2014, p. 213).

Another topic of interest is the effect of proprioceptive neuromuscular facilitation (PNF) on muscle tonus regulation. Nevertheless, PNF techniques that employ prolonged stretching and resistance exercises exert a modulatory effect on hypertonicity, pharmacopoeia, increase flexibility, and improve coordinated movement patterns (Guiu-Tula et al. 2017, p. 1).

Traditional physiotherapy approaches commonly employed in stroke rehabilitation include the Bobath method, task-oriented training, and conventional strength training in stroke rehabilitation (Murphy et al. 2020, p. 561). PNF facilitates a more active aspect of movement control, coordination, and proprioceptive feedback that is not as prevalent with passive stretching or resistance training and is thought to improve factors influencing functional motor recovery more successfully (George et al. 2017, p. 695).

Studies comparing PNF with traditional rehabilitation have shown positive results. Victoria et al. (2013, p. 623), static stretching or conventional resistance training resulted in lesser effects on neuromuscular control and coordination than the PNF interventions. Another study by Saini et al. (2021, p. S6) reported that participants who trained using PNF exhibited greater improvements in dynamic balance and postural stability, which can prevent falls in stroke survivors.

As the current available evidence favors PNF as a suitable rehabilitation method, its efficacy needs to be confirmed through a well-performed randomized controlled trial (RCT). While many studies have shown the efficacy of PNF, the majority have been small scale, observational or lacking rigorous methodological controls (Guiu-Tula et al. 2017, p. 1). An adequately powered high-quality RCT is needed to determine the clinical significance, optimal frequency, and long-term effects of PNF interventions in stroke rehabilitation (Murphy et al. 2020, p. 561).

Therefore, this study attempts to address this research gap by implementing a randomized controlled trial to evaluate the efficacy of PNF on muscle tone and balance in stroke patients. This study aims to fill the evidence gap regarding the role of PNF in achieving optimal post-stroke motor recovery, by comparing PNF-based therapy with traditional physiotherapeutic modalities (Pachruddin et al. 2020, p. 32033). The results have the potential to substantially influence clinical guidelines, optimize rehabilitation protocols and functional outcomes in stroke survivors.

Stroke rehabilitation is a continuously improving field and Proprioceptive Neuromuscular Facilitation (PNF) is one of the new intervention that helps to promote balance and muscle tone. PNF has a robust theoretical basis and growing empirical evidence supporting its wide clinical utility, but large-scale, carefully controlled studies on PNF remain sparse (Chaturvedi et al. 2018, p. 391). Thus, this study will help advance the field of stroke rehabilitation progression by providing rigorous evaluation of PNF on pivotal functional outcomes. If shown to be effective, PNF may be incorporated as a standard therapeutic strategy in stroke rehab programs, potentially enhancing the quality of life of millions of stroke survivors globally (Saini et al. 2021, p. 56).

## **1.2 Rationale**

The rationale for this study stems from the critical need to address the multifaceted challenges faced by stroke survivors during their rehabilitation process. Stroke not only affects motor function but also significantly impacts cognitive abilities, emotional health, and overall quality of life. Given the increasing prevalence of stroke in an aging population, understanding the most effective rehabilitation strategies is essential for improving patient outcomes and facilitating recovery. Among various rehabilitation techniques, Proprioceptive Neuromuscular Facilitation (PNF) has shown promise in enhancing functional recovery for stroke patients. However, there remains a gap in comprehensive understanding regarding its application, effectiveness, and the various factors influencing its outcomes. PNF is a therapeutic approach designed to improve movement patterns and restore motor function by integrating sensory input with motor responses. It is based on the principles of neurophysiology and emphasizes the importance of proprioceptive feedback, which is crucial for coordinating muscle activity and balance. Given the nature of stroke, where motor control and proprioception are often impaired, PNF presents an appealing option for rehabilitation. However, while many studies have highlighted its potential benefits, there is still a lack of consensus on its best practices, including optimal protocols, frequency of sessions, and the duration of interventions. Understanding the effectiveness of PNF in promoting balance and muscle tone in stroke patients is vital for developing evidence-based clinical guidelines. As stroke rehabilitation often involves a multidisciplinary approach, it is imperative to assess how PNF can fit into a broader rehabilitation framework alongside other interventions. This study aims to explore not only the direct effects of PNF on balance and muscle tone but also its potential to enhance overall functional independence in daily living activities. Ultimately, this study aims to provide a comprehensive evaluation of PNF's effectiveness in stroke rehabilitation, considering the myriad factors that influence patient outcomes. By synthesizing evidence from clinical practice and existing research, the study seeks to generate insights that can inform future rehabilitation protocols, enhance the quality of care provided to stroke survivors, and contribute to the development of best practice guidelines.

### **1.3 Research Question**

Is Proprioceptive Neuromuscular Facilitation (PNF) effective in improving balance and muscle tone in stroke patients?

#### **1.4 Aim**

The aim of the study was to investigate the effectiveness of PNF in improving Muscle tone and Balance among stroke patients.

## **1.5 Hypothesis of the study**

### **Null Hypothesis**

Proprioceptive Neuromuscular Facilitation (PNF) is not effective in improving balance and muscle tone in stroke patients.

$$\mu_1 - \mu_2 \neq 0 \text{ or } \mu_1 \neq \mu_2$$

### **Alternative Hypothesis**

Proprioceptive Neuromuscular Facilitation (PNF) is effective in improving balance and muscle tone in stroke patients.

$$\mu_1 - \mu_2 = 0 \text{ or } \mu_1 \geq \mu_2$$

Where,

Ho= Null hypothesis

Ha = Alternative hypothesis

$\mu_1$  = Mean difference in initial assessment

$\mu_2$  = Mean difference in final assessment

## **1.6 Objectives**

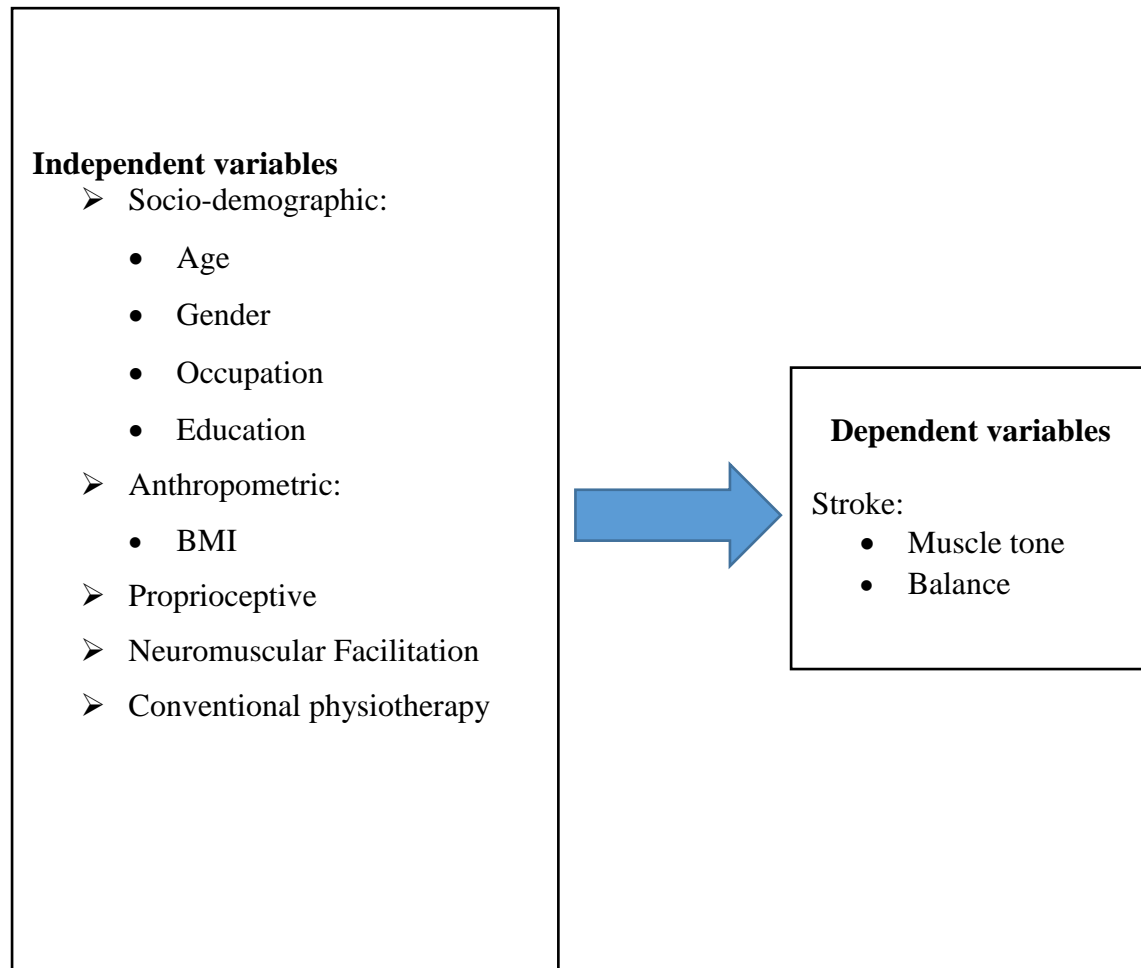
### **1.6.1 General Objectives**

To compare the effectiveness of proprioceptive neuromuscular facilitation versus conventional physiotherapy to improving balance and muscle tone in patients with stroke in Dhaka city.

### **1.6.2 Specific objectives**

- i To determine the sociodemographic profile of both experimental and control group
- ii To assess the muscle tone of stroke patients of experimental group by using Modified Ashworth Scale before and after PNF along with conventional physiotherapy
- iii To assess the level of balance of stroke patients of experimental group by using BBS before and after PNF along with conventional physiotherapy
- iv To assess the muscle tone of stroke patients of control group by using Modified Ashworth Scale before and after conventional physiotherapy
- v To assess the level of balance of stroke patients of control group by using BBS before and after conventional physiotherapy

## 1.7 List of variables:



## **1.8 Operational Definition**

### **Proprioceptive Neuromuscular Facilitation (PNF)**

PNF is defined as a therapeutic intervention that involves stretching, resistance exercises, and specific movement patterns designed to enhance neuromuscular control and motor learning. In this study, PNF will include 12 sessions over four weeks, focusing on techniques such as rhythmic stabilization and dynamic movements tailored to the participant's abilities and rehabilitation goals.

### **Balance**

Stroke patients must show the capacity to maintain their body position while static or engaging in dynamic actions. This condition is known as balance. The measurement of balance will use the validated Berg Balance Scale containing 14 tasks which can produce a maximum score of 56. The scoring system of the measurement reflects improved balance abilities.

### **Muscle Tone**

The definition of muscle tone describes the strength of resistance that passive stretching or body movement meets. The Modified Ashworth Scale (MAS) will serve to evaluate muscle tone through ratings from 0 (no increase in tone) to 4 (rigid muscle tone) in this research study. Net muscle tone and improved muscle function correlate with lower score results on this measurement scale.

### **Stroke Patients**

For this study, stroke patients are defined as adults diagnosed with either ischemic or hemorrhagic stroke who meet the inclusion criteria. These criteria include being medically stable, cleared for physiotherapy, and exhibiting motor impairments but without severe cognitive deficits or significant comorbidities.

### **Conventional Physiotherapy**

Conventional physiotherapy refers to standard rehabilitation practices provided to the control group. This includes exercises aimed at improving range of motion, muscle strength, and basic mobility. The intervention excludes PNF techniques and focuses solely on general physiotherapy protocols delivered over 12 sessions.

Stroke continues to be one of the most common causes of disability worldwide, with millions of people affected each year and posing a massive strain on healthcare systems around the world. An intricate and multifaceted neurological pathology that occurs following an acute blood flow disruption to the brain resulting in cell death, motor dysfunction and long-term disability (Murphy & Werring, 2020, p. 516). Survivors commonly display motor dysfunction, muscle weakness, impaired coordination, and reduced postural control, which can adversely affect functional independence and quality of life (Saini et al., 2021, p. 6) upon consideration of the condition and localisation of their stroke. Balance deficits (also known as a loss of stability), along with the regulation of muscle tone in dynamic movements, are the most common causative factors contributing to fall risk and limited movement post-stroke (Mindouri et al., 2021, p. 76). Stroke survivors cannot regain independence in daily activities due to inadequate rehabilitation, which forces them to be dependent on caregivers and rehabilitation services for long periods of time.

Understanding the importance of stroke rehabilitation is central to post-stroke recovery as it is a process aimed at recovering movement, balance, and muscle control to ensure stroke survivors can return to a relatively normal life (including ADLs) as quickly as possible (Murphy & Werring, 2020, p. 516). Numerous physiotherapeutic approaches were formulated through the years to correct these deficits: the Bobath approach, constraint-induced movement therapy (CIMT), task-specific training, and robot-assisted rehabilitation (Nguyen et al., 2022, p. 882). One of these is Proprioceptive Neuromuscular Facilitation (PNF), which has become a widely used strategy to improve neuromuscular function, balance and movement coordination in patients with stroke (Pachruddin et al., 2020, p. 6).

PNF is a neurophysiological approach that employs a combination of manual resistance, proprioceptive input, and specific movement patterns in order to facilitate muscle activation and retrain coordinated movement, (Chaturvedi et al., 2018, pg. 391). This approach activates the sensory-motor system by stimulating muscle spindles, Golgi tendon organs and joint receptors to facilitate muscle response, motor control and improving tone of reflective adjustments (Mindouri et al., 2021, p. 76). PNF not

only enables muscle strengthening, but because it emphasizes on functional movements that are representative of how the human body naturally moves, it is thought to be a more functional approach with better applicability in stroke recovery than traditional physiotherapy (Nguyen et al., 2022, p. 882).

This approach of using PNF techniques has started to be investigated in recent years with a considerable number of studies demonstrating their potential advantages in postural stability, muscle strength, and gait performance among stroke survivors (Victoria et al., 2013, p. 623). Studies have shown that PNF effectively increases motor units and improves neuromuscular coordination and facilitates motor patterns in the neural system (Kumar et al., 2020, p. 67). However, even though its benefits are well-established, PNF has not yet been adopted as a standard treatment method in stroke rehabilitation programs, highlighting the need for ongoing research into its long-term effectiveness and clinical applicability (Murphy & Werring, 2020, p. 516).

This literature review determines the efficacy of PNF in stroke rehabilitation, concentrating primarily on balance improvement and muscle tone adjustment. This review will evaluate the mechanisms behind how PNF facilitates improved outcome function, its efficacy in comparison to other rehabilitation strategies through synthesization of results from RCTs, systematic reviews, and clinical studies, as well as directions for exploration in future research. Knowledge of and insight into the relationship of PNF in post-stroke recovery can guide rehabilitation protocols that can enhance clinical decision making and add to individualized and comprehensive stroke rehabilitation management (Mindouri et al., 2021, p. 76).

Stroke is a leading cause of global morbidity and mortality, but its incidence and prevalence vary widely by geography, socioeconomic status, and demographic factors. Low- and middle-income countries (LMICs) carry the heaviest load with stroke rates nearly six times higher than high-income countries due to reduced availability of health services, limited knowledge about risk factor management, and higher incidence of uncontrolled risk factors (Saini et al., 2021, p. 6). According to Murphy & Werring (2020, p. 516), a staggering 13.7 million new strokes were diagnosed in the year 2016 alone in the world, of which 87% of the strokes were identified for being classified as ischemic strokes, which in itself is one of the biggest causes of long-term disability and even death. Stroke risk factors can be divided in two general categories: non-

modifiable and modifiable factors. Age, sex, ethnicity, and genetic background are non-modifiable risk factors, which inherently affect the susceptibility to stroke for the individual. [5] Stroke becomes more common with age, and while the risk of stroke is higher in men, women frequently suffer more post-stroke disability due to increased lifespan and postmenopausal vascular changes (Kim et al., 2020, p. 521). There are ethnic disparities too, with those of African-Caribbean and South Asian ancestry at greater risk than Caucasians, with a lot of that down to higher rates of hypertension, diabetes, and obesity (Murphy & Werring, 2020, p. 516). Other modifiable risk factors, including hypertension, diabetes mellitus, hyperlipidemia, smoking, obesity, and physical inactivity, play a major role in the prevalence of stroke, positioning prevention through lifestyle modifications and medical management as a priority (Nguyen et al., 2022, p. 882). In fact, alarming recent studies reveal increasing cases of ischemic stroke in younger patients aged 18-44 years, (Figueroa et al., 2022) especially due to rises in obesity, sedentary lifestyle, and increasing incidences of the metabolic syndrome (Guiu-Tula et al., 2017, p. 1). Likewise, socioeconomic determinants significantly affect stroke risks and rehabilitation access and outcomes, as insufficient healthcare resources, pricing pressures, and access inequalities often lead to late diagnosis and low stroke treatment and high rehabilitation rates in LMICs (Murphy & Werring, 2020, p. 516). These epidemiological patterns and risk factors are critical to informing targeted prevention strategies, facilitating access to stroke care and improving rehabilitation outcomes, particularly among at-risk populations.

Stroke rehabilitation is a complex and multidimensional process that aims to restore lost motor functions, including balance, functional independence and other aspects to be functional in life for stroke individuals. Various rehabilitation strategies have emerged, which can be categorized generally into neurophysiological, motor learning, and orthopedic strategies, each emphasizing a different target for motor recovery (Chaturvedi et al., 2018, p. 391). Neurophysiological approaches (e.g., Bobath Concept, and Proprioceptive Neuromuscular Facilitation [PNF]) stimulate the nervous system to restore motor control and coordination. The Bobath conceptualization routinely applied within stroke rehabilitation encourages inhibition of abnormal muscle tone and facilitation of normal patterns of movement whilst Motor Relearning Programmes (MRP) focus on the specific training required to recover appropriate functional movements (Pachruddin et al., 2020, p. 6). PNF has become particularly effective

because of its use of sensorimotor input, proprioceptive feedback, and diagonal movements that closely resemble natural motor function (Kim et al., 2019, p. 213).

PNF is frequently integrated during task-specific training, such as ramps and stair exercises, balance drills, and functional gait training to improve postural stability, gait performance, and muscle strength (Mindouri et al., 2021, p. 76). Nguyen et al. (2022, p. 882) It offers manual resistance, verbal cues, and proprioceptive stimulation, activating neuromuscular pathways and ultimately leading to improved motor control and coordination. Research has shown that interventions utilizing proprioceptive neuromuscular facilitation (PNF) "significantly improve both dynamic balance and walking endurance" (Kumar et al., 2020, p. 67) and, as such, should be considered as a vital aspect of post-stroke rehabilitation programs. There may be many variables which lead to the differences in PNF application among therapists which acts as a hindrance for standardization of PNF methods consequently affecting the efficacy of its performance (Pachruddin et al., 2020, p. 6). The study also notes the limited exploration of the long-term effects of PNF when compared to conventional physiotherapy, further underlining the need for more randomized controlled trials (RCTs) and larger clinical studies to confirm its effectiveness and establish how best to implement it in stroke recovery programs (Mindouri et al., 2021, p. 76). Overcoming these issues is a prerequisite for the inclusion of PNF into evidence-based rehabilitation algorithms that will improve functional independence and quality of life for stroke survivors.

Proprioceptive Neuromuscular Facilitation (PNF) is an advanced therapeutic modality that employs neurophysiological principles to influence motor control, muscle recruitment, and postural stability. Its effectiveness relies on mechanisms such as after-discharge, temporal and spatial summation, irradiation, successive induction and reciprocal inhibition, which are all important in increasing neuromuscular coordination and movement economy (Chaturvedi et al., 2020, p. 391)

Techniques of PNF which mostly emphasize different components of neuromuscular function have been widely incorporated in stroke rehabilitation programs. Rhythmic Initiation, another widely used approach, involves the gradual introduction of movement to not only improve motor coordination but is particularly favorable during the early stages of stroke rehabilitation. It promotes the shift from passive to active

movement patterns, and allows patients to regain voluntary control over impaired motor function. The opposite of that are Stabilizing Reversals, and these are key to improving postural control and core stability, critical for balancing on their feet, as well as preventing falls (important for all stroke survivors). The second PNF method, known as Hold-Relax and Contract-Relax, is designed for reducing muscle spasticity, increasing joint range of motion, and improving flexibility (Mindouri et al., 2021, p. 76). These techniques not only guarantee that stroke patients can perform movements that coordinate the body, execute them correctly, and decrease the chance of other complications like contractures and atrophy of muscles.

The wide application of PNF approaches in many clinical rehabilitation environments has been attributed to their versatility and their ability to be adapted to the patients' needs during the different phases of stroke recovery. The practical application of PNF must also be recognised as it not only involves muscle activation, as opposed to conventional strength-training exercises, but additionally enhances neuro-muscular pathways, and therefore represents a highly effective approach in increasing functional independence for stroke survivors (Nguyen et al., 2022, p. 882). Its incorporation in traditional physiotherapy protocols, especially if paired with task-oriented training, has shown marked benefits in postural control, walking quality, and global motor abilities. Nonetheless, planning more clinical trials to standardize the PNF in stroke rehabilitation, particularly treatment dosing, will also contribute to increased efficacy.

The literature on the effectiveness of PNF in stroke rehabilitation is vast; the technique has been shown to increase balance, muscle strength, flexibility, gait performance, and overall functional mobility. PNF has many benefits, one of the most important being its effect on balance and postural control, two aspects of mobility that help prevent falls and contribute to independence in stroke survivors. And on a systematic review and meta-analyses' base level, the effect of PNF on balance has been reported in these studies and its results showed a significant increase in balance through Berg Balance Scale (BBS), Functional Reach Test (FRT) and Timed Up and Go Test (TUG) tests for balance, these tests are comparing postural stability and risk of falling which is reliable clinical assessment that indicates a risk of falling (Nguyen et al., 2022, p. 882). These benefits can be primarily attributed to proprioceptive feedback provided by PNF training, which strengthens core muscles and enhances the ability to shift weight with

precision, leading to improvements in maintaining an upright posture and the ability to initiate controlled and coordinated movements.

In addition to improving balance, PNF has also proven to be highly effective in decreasing muscle stiffness and increasing motor coordination in both lower extremities. Such increased muscle tone, spasticity, and the limited range of motion in stroke survivors can be debilitating and greatly hinder functional skills. Similar studies also mention that techniques such as Hold-Relax and Contract-Relax of PNF contribute to the reduction of spasticity, the promotion of joint free movement and to restoring coordinated flow of movement (Pachruddin et al., 2020, p. 6). In addition, PNF-based stretching and resistance exercises are a preventive measure against the development of joint contractures and muscle atrophy, both of which are common secondary complications of post-stroke immobilization.

Market acceptance is another broad area in which PNF has been shown to be clinically effective, such as gait performance and functional mobility. Known deficits for stroke patients include decreased stride length, decreased cadence, and decreased walking velocity, which are detrimental in performing activities of daily living. Research has shown that PNF-based gait training programs produce marked improvements in stride length, step symmetry, and gait velocity (Kumar et al., 2020, p. 67). Furthermore, the combination of PNF with task-oriented practice, including ramping and stair climbing, has been shown to improve walking endurance and dynamic balance, further highlighting exercise's role in stroke survivors as they transition back to independent ambulation.

Guiu-Tula et al. (2017, p. 1) add this evidence to support PNF role in stroke rehabilitation by showing its positive effects on Activities of Daily Living (ADLs) and quality of life. Stroke patients who received PNF therapy showed considerable advancements in their capacity to complete daily activities like dressing, bathing, and transitioning from one posture to another, which ultimately led to decreased reliance on caregivers. But even with the appendix that demonstrates clinical viability of PNF, patient response and variability is still a missing piece of the puzzle and a continuing thread that needs to be addressed with individualized rehabilitation approaches (Kim et al., 2019, p. 213). Specifically, in PNF, stroke severity, concomitant diseases, cognitive ability, and patient motivation are determining factors for PNF outcome

leading to patient-centered PNF approaches that adjust intensity and techniques according to individual demands. RCTs with larger populations, multicenter collaboration, combined with meta-analysis data are required to assist in developing standardized protocols to incorporate PNF into established stroke rehabilitation regimens specifically designed to maximize long-term functional outcomes.

Background: Although Proprioceptive Neuromuscular Facilitation (PNF) has been well-documented as an effective part of stroke rehabilitation for decades, the challenges and limitations behind implementing PNF into clinical practice remain. Standardization of PNF protocols has not been in place which is one of the main reasons for a high variability of outcome between rehabilitation environments (Mindouri et al., 2021, p. 76). In contrast to other conventional stroke rehabilitation strategies such as the constraint-induced movement therapy (CIMT) or the Bobath concept, no consensus exists in PNF treatment, hence ideal frequency, intensity, and duration of treatment remain to be determined for a marked recovery [3, 6–10]. The lack of standard guidelines leads to within-consistency in application by healthcare providers, which places challenges on determining effective practices and anticipated patient outcomes. Some studies have shown substantial improvements in balance, muscle tone and functional mobility following PNF treatment, while others report large inter-individual variability, suggesting that PNF may not be equally effective for all stroke patients (Pachruddin et al., 2020, p. 6).

The absence of trained physiotherapists and limited access to PNF certified specialists, especially in low- and middle-income countries (LMICs), is another key challenge restricting PNF adoption in clinical practice (Guiu-Tula et al., 2017, p. 1). To properly apply PNF techniques, an adequate level of physical familiarity, knowledge of the techniques, and understanding of how neuromuscular facilitation works are needed, which are not always part of the standard physiotherapy course. Embarking on some PNF-based rehabilitation program requires certain infrastructure and well-trained professionals, and not many rehabilitation centers, especially in resource-scarce settings, possess them. However, this shortage of trained specialists limits patient access to good quality PNF interventions and perpetuates inequalities in stroke recovery outcomes between the developed and developing world. Additional, more accessible

training opportunities for physiotherapists in PNF could also be achieved by incorporating PNF into physiotherapy education.

Additionally patient-specific factors influence PNF's capacity for stroke recovery, as stroke is a highly individualized experience (Murphy & Werring, 2020, p. 516). Stroke Severity, Pre-Existing Comorbidities, Age, Cognitive Function and Motivation Levels: The most effective patient response to PNF interventions will vary according to factors such as stroke severity, pre-existing comorbidities, age, cognitive function and motivation levels. Example: PNF techniques that necessitate cognitive contribution or something of that sort would not be suitable for individuals who have severe motor disabilities or significant cognitive decline. Moreover, some conditions such as arthritis, cardiovascular disease, or neurological disorders can significantly hinder a patient's ability to perform PNF movements properly, and decrease the general efficacy of treatment. This emphasizes the importance of tailoring rehabilitation approaches to individual stroke survivors, including adjusting PNF techniques to their unique clinical poststroke profiles.

Addressing these challenges can facilitate the integration of PNF into conventional stroke rehabilitation programs, paving the way for improved recovery and quality of life post-stroke. There exist also some at the same time research truncation and future road to study given the large volume of literature around PNF in stroke rehabilitation. Full incorporation of PNF as a standardized stroke rehabilitation strategy depends on further research and attention to important limitations to expand its clinical applicability. A major area of need is long-term efficacy studies that measure sustained functional improvement beyond six months (Nguyen et al., 2022, p. 882). A number of these existing studies have looked mainly at shorter-term outcomes, such as gains in balance, muscle tone and mobility over weeks or months. However, whether these gains are maintained and whether ongoing PNF therapy is required for sustained benefits remains unanswered. Future longitudinal RCTs should assess further the long-term influence of PNF not only on functional independence but also on secondary stroke prevention and neuroplasticity adaptations among survivors.

Future trials should also examine PNF in comparison to alternative rehabilitation modalities including technologies driven methods such as functional electrical stimulation (FES), constraint-induced movement therapy (CIMT), and mirror therapy

(Guiu-Tula et al., 2017, p. 1). There is evidence to suggest that PNF is very effective however it is unclear how PNF compares with other evidence based interventions regarding efficacy, cost-effectiveness and adherence to treatment by patients. Head-to-head comparative studies will define which patient populations are most likely to benefit from PNF, and the use of PNF as a main treatment option or in combination with other treatment modalities. Also, comparative studies exploring various PNF protocols with different intensity, frequency and duration are required, with the aim of developing standard guidelines for clinical practice.

Outside of clinical research, policy-level intervention is needed to improve access to PNF-based rehabilitation programs, especially in LMICs with limited infrastructure for stroke care (Murphy & Werring, 2020, p. 516). Numerous LMICs have no trained PNF specialists, and physiotherapy services are prohibitively expensive for most people. Further studies should investigate more cost-efficient models of PNF delivery, such as rehabilitation programs in the community, tele-rehabilitation and programs to train healthcare personnel through government funding. Global stroke rehabilitation guidelines that include PNF as a recommended intervention could also facilitate standardisation of PNF in care protocols internationally.

Proprioceptive Neuromuscular Facilitation (PNF) is commonly used as a treatment in stroke rehabilitation and Research Shows that it is beneficial in attaining balance, regulation of muscle tone and overall functional mobility. PNF, by utilizing neurophysiological principles, activates proprioceptive feedback mechanisms that promote motor learning, neuromuscular coordination and postural stability (Mindouri et al., 2021, p. 76) and serves an integral component of stroke recovery programs. In contrast to conventional physiotherapy methods, PNF emphasizes dynamic patterns of movement and sensorimotor integration that result in improved independence in ADLs and enhanced quality of life for stroke survivors. The adaptability of PNF permits it to be utilized at different points of rehabilitation, so it's appropriate for a wide array of post-stroke deficits, including mild mobility limitations to significant motor deficits.

Although PNF has demonstrated efficacy, the widespread application of this treatment is limited by a number of challenges and barriers. There is very little agreement in the protocols used in PNF, which may lead to wide variance in outcome measures as well as difficulty in identifying the ideal frequency, intensity and duration of therapy for

specific patient populations. Moreover, access to properly-trained PNF specialists continues to be restricted, especially in low- and middle-income countries (LMICs) that have limited healthcare infrastructure and rehabilitation services (Nguyen et al., 2022, p. 882). In addition, individual patient characteristics, including stroke severity, cognitive performance, comorbidities, and motivation level, affect treatment response, highlighting the necessity of tailored rehabilitation strategies. The solution to overcoming these barriers will require a multi-pronged approach that encompasses an expansion of PNF training to physiotherapists, the integration of PNF with newer rehabilitative technology (robotics; virtual reality), and running large scale clinical trials to form evidence-based guidelines.

More well-designed RCTs and multi-disciplinary collaborations would be helpful to better implement PNF into global stroke rehabilitation regimes. Future studies need to examine longer-term effectiveness, comparative trials with other rehabilitation methods, and cost-effective models for the application of PNF in resource-limited contexts (Nguyen et al., 2022, p. 882). Policy-level interventions that focus on enhancing access to PNF, funding for stroke rehabilitation, and increasing awareness among the healthcare providers will play an important role in bridging the gap in access to effective rehabilitation interventions globally. With further developments in PNF science, clinical proficiency and public health systems, this method could become a validated and widespread rehabilitative approach on a broader international scale, enhancing the recovery and social well-being of many millions of people affected by a stroke.

### **3.1. Study Design**

This research used the study design of randomized controlled trial, with two groups of participants. The purpose of randomized control study was to assess the impact of the Proprioceptive Neuromuscular Facilitation (PNF) added to conventional physiotherapy against conventional physiotherapy alone on improvement in muscle tone and balance in patients with stroke. Amongst other things, all of this aligns with a true experimental framework: random allocation of participants; blinding for the assessors; and consistent treatment protocols for the experimental and control groups.

### **3.2. Study site**

The study was conducted at Ibn Sina Diagnostic & Consultant Centre, Uttara. Ibn Sina D-Lab Keraniganj.

### **3.3 Study place:**

The study was conducted at Saic College of Medical Science and Technology (SCMST) at Mirpur, Dhaka.

### **3.4 Study period:**

The study period was one year. (September 2023 to August 2024).

### **3.5 Study Population**

The study population was determined based on a comprehensive review of the literature and alignment with the study's objectives. The inclusion criteria were carefully developed to reflect the theoretical framework and assumptions underlying the research. Participants with stroke were recruited from two physiotherapy centers in Dhaka. These individuals represented a diverse demographic group meeting specific clinical criteria for stroke rehabilitation, including motor impairments, balance deficits, and muscle tone abnormalities. Recruitment focused on individuals who were medically stable, cleared for physiotherapy, and had experienced a stroke within the past six months. Ethical guidelines were strictly followed to ensure that the selected

population accurately represented the target group for assessing the effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) combined with conventional physiotherapy compared to conventional physiotherapy alone.

### 3.6 Sample size

It's tough to determine the optimal sample size because it varies heavily on the type of study being conducted. Planning is the key to success in any statistical study. The study's sample size should be sufficient in light of its aims. The study's sample size should be "big enough" to ensure that any effect large enough to be scientifically significant is also statistically significant.

$$k = \frac{n_2}{n_1} = 1$$

$$n_1 = \frac{\left(\sigma_1^2 + \sigma_2^2 / K\right) \left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2}{\Delta^2}$$

$$n_1 = \frac{(1.48^2 + 1.48^2 / 1) (1.96 + 1.04)^2}{1.39^2}$$

$$n_1 = 25$$

$$n_2 = K \times n_1 = 20$$

Here,

$\Delta = \mu_2 - \mu_1 =$  absolute difference between two means

$\sigma_1, \sigma_2 =$  variance of mean 1 and 2

$n_1 =$  sample size for group 1

$n_2 =$  sample size for group 2

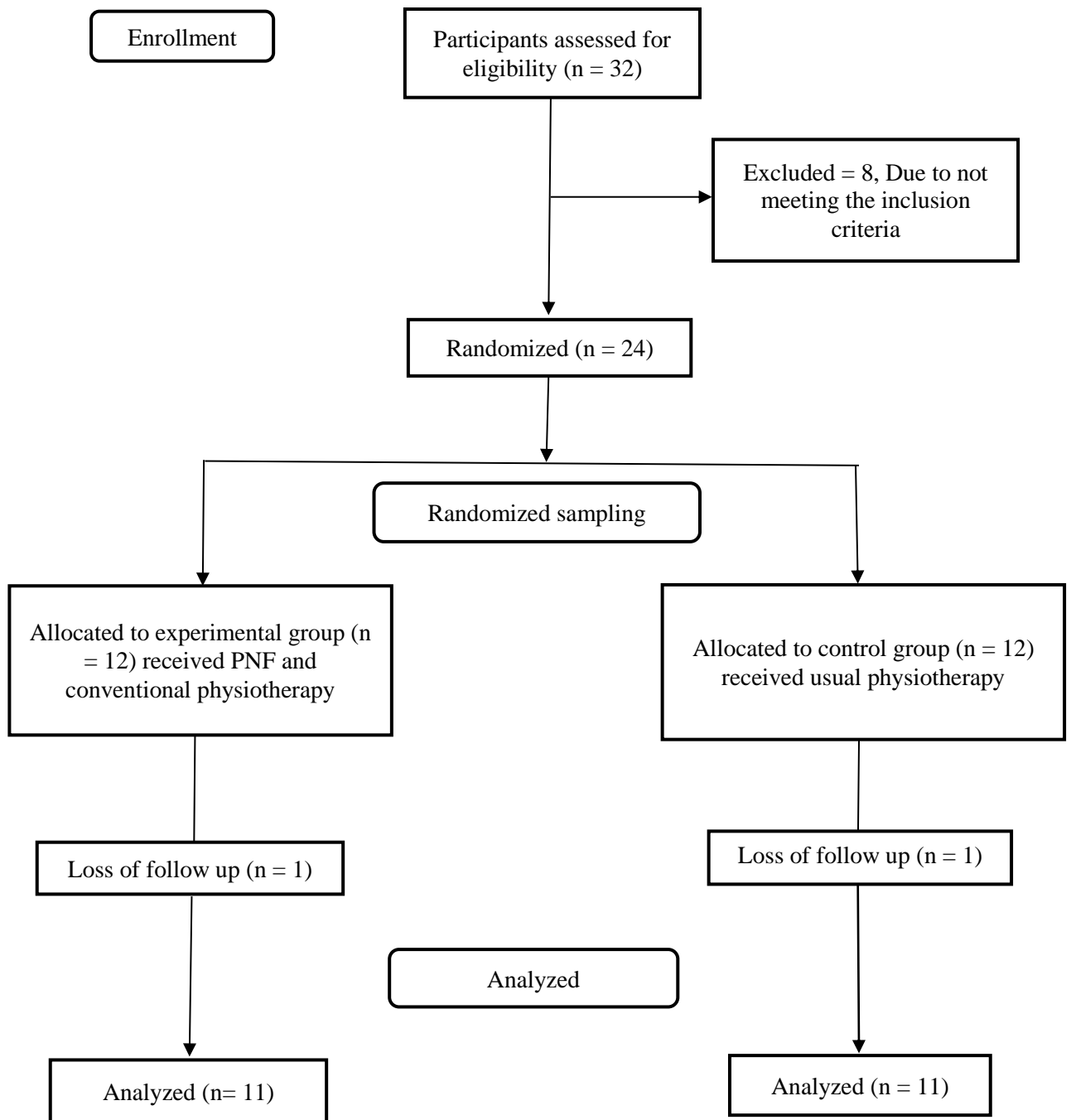
$\alpha =$  probability of type I error (usually 0.05)

$\beta =$  probability of type II error (usually 0.2)

$z =$  critical Z value for a given  $\alpha$  or  $\beta$

$k =$  ratio of sample size for group 2 to group 1

### 3.7 CONSORT (Consolidated Standards of Reporting Trials) flow chart:



### **3.8 Sampling technique**

A simple random sampling technique was employed in this study to ensure unbiased participant selection and enhance the validity of the findings. The sampling frame consisted of stroke patients undergoing physiotherapy rehabilitation at two physiotherapy centers in Dhaka. Participants who met the inclusion and exclusion criteria were assigned a unique identifier. A computer-generated randomization process was then used to allocate participants into two groups: the experimental group, which received Proprioceptive Neuromuscular Facilitation (PNF) combined with conventional physiotherapy, and the control group, which received only conventional physiotherapy. This approach minimized selection bias and ensured that each eligible participant had an equal chance of being assigned to either group, thereby supporting the integrity of the study design.

### **3.9 Eligibility criteria:**

#### **3.9.1 Inclusion Criteria**

- i. Adult patients diagnosed with ischemic stroke (Winstein et al. 2016, p. 98).
- ii. 30-70 years of age (Mindouri et al., 2021, p. 76).
- iii. All are acute, subacute and chronic stroke
- iv. Both male and female
- v. Patients who are medically stable and cleared for physiotherapy (Lo et al., 2017).
- vi. Patients with a certain level of motor impairment suitable for the study
- vii. Patients who can understand and follow simple instructions (Li et al. 2019, p. 268).

#### **3.9.2 Exclusion Criteria**

- i. Subjects who will not be willing to participate
- ii. Patients with cognitive problems (Arienti et al. 2019, p. 298).
- iii. Undiagnosed patients (Winstein et al. 2016, p. 98).
- iv. Significant comorbidities, such as severe cardiac or orthopedic issues

### **3.10 Data collection tools**

The Bengali Consent form and questionnaire were required, as well as a pen, pencil, eraser, clipboard, white paper, and a notebook.

### **3.11 Measurement Tools**

#### **i. Berg Balance Scale (BBS):**

The Berg Balance Scale is a commonly used tool to assess balance performance in the neurological condition stroke. The consortium consists of 14 items to test a person's ability to keep balanced during a series of tasks – sitting, standing and reaching. Even topics that don't necessarily need to be scored get a score on a scale of 0 to 4 with a maximum of 56. Higher scores indicate better balance. As a tool for this study the BBS has a high reliability, validity, and sensitivity to changes in balance over time.

#### **ii. Modified Ashworth Scale (MAS):**

The Clinical instrument used to measure spasticity in people with neurological impairments is the MMP Scale (modified assetsworth scale). It describes the range of resistance to passive movement in muscles and is scored from 0 (to no increase in muscle tone) to 4 (extending rigidly or flexing rigidly). Stroke rehabilitation is a typical application for the MAS which provides a standardized method to evaluate the changes in muscle tone after interventions.

### **3.12 Instrument of data collection:**

The pretested structured questionnaire was used as an instrument of data collection. The questionnaire had parts. The first part contained questions on patient identification. The second part included questions on sociodemographic information. The third part contained questions on assessment related variables.

### **3.13 Data Collection Procedure**

The data was gathered via closed-ended interviews and questionnaires with predetermined answers. As a result of the flexibility it provided in its questions and answers, the structural questionnaire proved useful to the researcher in gathering all the necessary data. To get to the truth about every facet of the participant, the researcher created a structured, closed-ended questionnaire to collect data on socio-demographic characteristics.

### **3.14 Level of Significance**

We calculated 'p' value and came to know how relevant is the study. We took a p value of 0.05 as the extent to which statistical significance for health care research. Then the results are said to be significant if the p value is less than or equal to the significance level.

### **3.15 Ethical consideration**

In this study, it is imperative that they were strict followers to ethical guidelines. A formal project proposal was submitted to the Department of Physiotherapy, Saic College of Medical Science and Technology (SCMST), and approval based on Institutional Review Board (IRB) of SCMST had been given to conduct the study. This study is in conformity with the guidelines provided by the World Health Organization (WHO) and Bangladesh Medical Research Council (BMRC) and keeps the confidentiality of information from the participants intact at all times. The study area authorities permission to collect data has also been obtained. The aim and objectives of the study would be fully explained to participants before they are willing to participate. Each participant will be granted written consent and explained to process verbally. The information that will be given to the participants will be assured that it will be kept confidential, but only shared with the research supervisor. Participants will be told when they have a right to withdraw from the study without any repercussions. Participant names and addresses will be replaced with distinct participation numbers for reasons of anonymity, and participation numbers will be used in all notes and transcripts. The information gathered will be presented in presentation, seminar or paper in such a way that there is no identification of individuals or causing them harm. All participants will be assured their right to ask senior authorities about any issues and concerns surrounding the study. Therefore, the ethics standards followed in this study are particularly meant to protect welfare of participants as well as the process of the research at the same time.

### **3.16 Intervention:**

#### **PNF-Based Protocol**

##### **Assessment**

1. **Spasticity:** Evaluate using the Modified Ashworth Scale (MAS).
2. **Balance:** Measure with the Berg Balance Scale (BBS).

##### **Frequency and Duration**

- **Sessions:** Five per week for 8 weeks.
- **Session Length:** 60 minutes, inclusive of warm-up and cool-down.

##### **Intervention Components**

1. **Rhythmic Initiation:**
  - Helps patients initiate movement patterns with guided assistance.
  - Example: Rhythmic flexion and extension of the upper limbs.
2. **Hold-Relax:**
  - Used to reduce spasticity and increase the range of motion.
  - Applied to major joints (e.g., shoulder, hip).
3. **Contract-Relax:**
  - Focuses on improving strength and dynamic control.
  - Involves resistance during contraction, followed by passive stretching.
4. **Dynamic Reversals:**
  - Alternating concentric contractions to improve stability.
  - Example: Alternating flexion and extension of the lower limb in a seated position.
5. **Functional Integration:**
  - Combine PNF patterns with ADL-specific tasks such as reaching or sit-to-stand transitions.
6. **Gait Training:**
  - Integrate diagonal PNF patterns to facilitate walking mechanics.

## **Outcome Measures**

1. **Spasticity Reduction:** Decreased MAS scores post-intervention.
2. **Balance Improvement:** Enhanced BBS scores.
3. **Functional Independence:**
  - Improved scores in FIM and 10 MWT.

## **Progression Plan**

- Gradual increase in resistance and complexity of movement patterns.
- Incorporate functional training, focusing on patient-specific goals.

## **Key Considerations**

- Tailor exercises to individual capabilities and stroke severity.
- Monitor patient safety and avoid overexertion.

(Guiu-Tula et al., 2017, p. 44)



**Figure:** PNF intervention

This study aimed to evaluate the effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) in improving balance and reducing muscle spasticity among stroke patients. The results are presented in this chapter, highlighting significant improvements observed in the experimental group compared to the control group. Key findings include substantial reductions in muscle tone abnormalities, as measured by the Modified Ashworth Scale (MAS), and notable enhancements in balance performance, as assessed by the Berg Balance Scale (BBS). Statistical analyses revealed that PNF, when combined with conventional physiotherapy, led to greater functional gains than conventional physiotherapy alone. The following sections provide a detailed analysis of participant demographics, baseline characteristics, and post-intervention outcomes, demonstrating the clinical potential of PNF as a rehabilitation strategy for stroke recovery.

**Table no 4.1: Frequency percentage of sociodemographic information of participants:**

<b>Variable</b>	<b>Experimental Group N (%)</b>	<b>Control Group N (%)</b>	<b>P value</b>
<b>Gender</b>			
Male	11 (100%)	10 (90.9%)	0.306
Female	0 (0%)	1 (9.1%)	
<b>Marital Status</b>			
Married	11 (100%)	11 (100%)	1.000
Unmarried	0 (0%)	0 (0%)	
<b>Family Type</b>			
Joint	5 (45.5%)	3 (27.3%)	0.375

Nuclear	6 (54.5%)	8 (72.7%)	
<b>Living area</b>			
Rural	2 (18.2%)	2 (18.2%)	1.000
Urban	9 (81.8%)	9 (91.8%)	
<b>Educational Qualification</b>			
Illiterate	0 (0.0%)	0 (0.0%)	0.209
Primary	1 (9.1%)	5 (45.5%)	
Secondary	3 (27.3%)	2 (18.2%)	
Higher secondary	4 (36.4%)	1 (9.1%)	
Bachelor	3 (27.3%)	2 (18.2%)	
Masters	0 (0.0%)	1 (9.1%)	
<b>Occupation</b>			
Unemployed	4 (36.4%)	5 (45.5%)	0.271
Day labor	0 (0.0%)	0 (0.0%)	
Desk job	3 (27.3%)	3 (27.3%)	
Farmer	0 (0.0%)	2 (18.2%)	
Athlete	0 (0.0%)	0 (0.0%)	
Others	4 (36.4%)	1 (9.1%)	
<b>Age</b>			

31-40	2 (18.2%)	3 (27.3%)	0.982
41-50	2 (18.2%)	2 (18.2%)	
51-60	3 (27.3%)	2 (18.2%)	
61-70	3 (27.3%)	3 (27.3%)	
71-80	1 (9.1%)	1 (9.1%)	
<b>Total</b>	11 (100%)	11 (100%)	

The sociodemographic traits of the participants in both the experimental and control groups were investigated to ascertain their comparability based on the outcomes shown in Table 4.1. There were 22 participants total, evenly distributed between the experimental (n=11) and control (n=11) groups. With all members of the experimental group male (100%) and one female (9.1%), gender distribution revealed a male predominance. Since every participant in both groups was married, marital status was same across both. With 45.5% from joint families and 54.5% from nuclear families, family structure analysis revealed a rather balanced representation in the experimental group; the control group had a higher percentage of nuclear family participants (72.7%).

With just a small percentage from rural areas (18.2% in both groups), most of the participants in both groups lived in urban areas (experimental: 81.8%, control: 91.8%). Levels of educational qualification varied; the control group (45.5%) had a greater proportion of primary education than the experimental group (9.1%). Still, the experimental group included more participants with bachelor's degrees (27.3%) and higher secondary education (36.4%). Occupational distribution showed a noteworthy proportion of unemployed people in both groups experimental: 36.4%, control: 45.5%. While the control group consisted of two farmers (18.2%), a category lacking in the experimental group, desk job holders were equally distributed (27.3% in each group).

With the largest proportion of participants in the 61–70 age range (27.3% in both groups), age distribution was rather similar among the groups. With no statistically significant difference between the experimental and control groups  $p=0.692$  their mean ages were  $55.55 \pm 13.20$  and  $53.36 \pm 11.39$  years respectively. These results imply that the participants' sociodemographic traits were rather well matched between the groups, so reducing possible study confounds.

**Table no 4.2: Baseline characteristics of participants**

Variable	Experimental Group	Control Group	<i>p</i> -value
	Mean $\pm$ SD		
Age	55.5 $\pm$ 13.20	53.36 $\pm$ 11.39	0.692
BMI	23.61 $\pm$ 2.74	22.82 $\pm$ 3.67	0.449
BBS	34.09 $\pm$ 1.81	35.09 $\pm$ 2.50	0.331
Left Hip Flexors	2.27 $\pm$ 0.46	2.45 $\pm$ 0.52	0.386
Right Hip Flexors	2.54 $\pm$ 0.52	2.45 $\pm$ 0.52	0.677
Left Knee Flexors	2.72 $\pm$ 0.46	2.63 $\pm$ 0.50	0.069
Right Knee Flexors	2.45 $\pm$ 0.52	2.45 $\pm$ 0.52	1.000

The mean age (experimental: 55.5  $\pm$  13.20, control: 53.36  $\pm$  11.39,  $p = 0.692$ ) and BMI (experimental: 23.61  $\pm$  2.74, control: 22.82  $\pm$  3.67,  $p = 0.449$ ) showed no significant differences. Balance, measured by the Berg Balance Scale (BBS), was slightly lower in the experimental group (34.09  $\pm$  1.81) than in the control group (35.09  $\pm$  2.50), but the difference was not statistically significant ( $p = 0.331$ ). Muscle tone, assessed using the Modified Ashworth Scale, showed no significant differences between groups across all measured muscle groups ( $p > 0.05$ ). These results confirm that both groups were well-matched at baseline, allowing for unbiased comparisons of post-intervention outcomes.

**Table 4.3: Wilcoxon test results Modified Ashworth Scale changes within group:**

<b>Variable</b>	<b>Group</b>	<b>Pre-Treatment Mean</b>	<b>Post-Treatment Mean</b>	<b>Wilcoxon Signed Rank Value</b>	<b>p-value</b>
<b>Left Hip Flexors</b>	Experimental	2.27	1.64	-3.071	.002
	Control	2.45	2.00	-2.236	.025
<b>Right Hip Flexors</b>	Experimental	2.55	1.77	-3.017	.003
	Control	2.45	2.00	-2.236	.025
<b>Left Knee Flexors</b>	Experimental	2.73	1.86	-3.071	.002
	Control	2.64	2.00	-2.646	.008
<b>Right Knee Flexors</b>	Experimental	2.45	1.73	-3.071	.002
	Control	2.45	2.00	-2.236	.025

The Wilcoxon signed-rank test results presented in Table 4.3 demonstrate the significant changes in muscle spasticity as measured by the Modified Ashworth Scale (MAS) within both the experimental and control groups. In the experimental group, all measured muscle groups exhibited statistically significant reductions in spasticity post-treatment, as indicated by negative ranks and low p-values. Specifically, the left hip flexors showed a mean reduction from 2.27 to 1.64 ( $p = .002$ ), the right hip flexors decreased from 2.55 to 1.77 ( $p = .003$ ), the left knee extensors improved from 2.73 to 1.86 ( $p = .002$ ), and the right knee extensors from 2.45 to 1.73 ( $p = .002$ ). In contrast, the control group showed less pronounced improvements, with p-values remaining significant but relatively higher, such as .025 for both hip flexors and .008 for the left knee extensors. These results suggest that the experimental intervention, incorporating Proprioceptive Neuromuscular Facilitation (PNF), was more effective in reducing spasticity compared to conventional physiotherapy alone, underscoring its potential benefits in enhancing motor recovery for stroke patients.

**Table 4.4: Mann-Whitney U test results Modified Ashworth Scale changes between group:**

<b>Variable</b>	<b>Category of participants</b>	<b>N</b>	<b>Mean Rank</b>	<b>Sum of Ranks</b>	<b>Mann Whitney U score</b>	<b>P</b>
<b>Left Hip Flexors</b>	<b>Experimental</b>	11	7.50	82.50	-3.464	0.001
	<b>Control</b>	11	15.50	170.50		
	<b>Total</b>	22				
<b>Right Hip Flexors</b>	<b>Experimental</b>	11	9.00	99.00	-2.485	0.013
	<b>Control</b>	11	14.00	154.00		
	<b>Total</b>	22				
<b>Left Knee Flexors</b>	<b>Experimental</b>	11	10.00	110.00	-1.821	0.069
	<b>Control</b>	11	13.00	143.00		
	<b>Total</b>	22				
<b>Right Knee Flexors</b>	<b>Experimental</b>	11	8.50	93.50	-2.806	0.005
	<b>Control</b>	11	14.50	159.50		
	<b>Total</b>	22				

As confirmed by the data in Table 4.4, which provides the results of the Mann-Whitney U test, there were significant differences in the reduction of spasticity, as determined by the Modified Ashworth scale, between the experimental and control groups for most muscle groups. Between group difference was the highest for the left hip flexors with the mean rank of the experimental group being significantly lower (7.50) than the mean rank in the control group (15.50); the Mann-Whitney U score is -3.464 and the p value is 0.001. Like the right hip flexors the right hip flexors of the experimental group also made very good gains with a mean rank of 9.00 compared to 14.00 of the control group ( $U = -2.485$ ,  $p = 0.013$ ).

Statistically significant difference was also found on the right knee flexors mean rank of 8.50 in experimental group compared to 14.50 in control group ( $U = -2.806$ ,  $p = 0.005$ ). On the other hand, the left knee flexors were not significantly different between groups with a U score of -1.821 and p value of 0.069.

In conclusion, these findings show that the experimental intervention based on PNF was superior than the conventional physiotherapy in reducing spasticity and in particular for the left hip flexors, right hip flexors, right knee flexors. For the left knee flexors, there was little difference and the possibility for such variability warrants further study.

**Table 4.5: Wilcoxon test results Analysis of Balance of Berg Balance Scale within group:**

Variable	Group	Pre-Treatment Mean	Post-Treatment Mean	Wilcoxon Signed Rank Value	<i>p</i> -value
<b>BBS</b>	Experimental	34.09 ± 1.81	48.00 ± 1.54	-2.955	0.003
	Control	35.09 ± 2.50	41.73 ± 1.54	-2.969	0.003

The Wilcoxon signed-rank test results in Table 4.5 illustrate significant improvements in balance, as assessed by the Berg Balance Scale (BBS), within both the experimental and control groups. For the experimental group, the pre-treatment mean BBS score of  $34.09 \pm 1.81$  increased to  $48.00 \pm 1.54$  post-treatment. This improvement, with a Wilcoxon signed-rank value of -2.955 and a *p*-value of 0.003, reflects a substantial enhancement in balance performance following the intervention, which included Proprioceptive Neuromuscular Facilitation (PNF).

In the control group, the pre-treatment mean BBS score of  $35.09 \pm 2.50$  also increased significantly to  $41.73 \pm 1.54$  post-treatment, with a Wilcoxon signed-rank value of -2.969 and a *p*-value of 0.003. While both groups demonstrated statistically significant improvements in balance, the experimental group exhibited a larger improvement in mean BBS scores, suggesting the superior effectiveness of the PNF-based intervention in enhancing balance compared to conventional physiotherapy alone. This finding supports the potential of PNF to be integrated into stroke rehabilitation protocols to achieve better balance outcomes.

**Table 4.6: Mann-Whitney U test results Analysis of Balance of Berg Balance Scale between group:**

	<b>Category of participants</b>	<b>N</b>	<b>Mean Rank</b>	<b>Sum of Ranks</b>	<b>Mann Whitney U score</b>	<b>P</b>
<b>BBS Post Treatment</b>	<b>Experimental</b>	11	16.41	180.50	-3.589	0.001
	<b>Control</b>	11	6.59	72.50		
	<b>Total</b>	22				

The Mann-Whitney U test results in Table 4.6 reveal a significant difference in post-treatment balance, measured by the Berg Balance Scale (BBS), between the experimental and control groups. The experimental group had a substantially higher mean rank (16.41) compared to the control group (6.59), with sum of ranks of 180.50 and 72.50, respectively. This resulted in a Mann-Whitney U score of -3.589 and a highly significant p-value of 0.001.

These results indicate that participants in the experimental group, who underwent Proprioceptive Neuromuscular Facilitation (PNF) in addition to conventional physiotherapy, experienced significantly greater improvements in balance compared to the control group, which received only conventional physiotherapy. This finding underscores the added benefit of incorporating PNF techniques into rehabilitation protocols to achieve superior outcomes in balance enhancement for stroke patients.

The age distribution in this study, with the majority of participants falling into the 61–70 years age group, aligns with the demographic profile of stroke patients commonly reported in the literature. For example, Chou et al. (2022, p. 882) in their systematic review of PNF-based therapies noted a similar mean age of participants in stroke rehabilitation studies. The balanced distribution of nutritional status in this study further underscores its applicability, as adequate nutrition is a critical factor in recovery, as highlighted by Asghar et al. (2023, p. 39), who reported that BMI directly influences the effectiveness of neuromuscular therapies.

The significant reduction in spasticity across all muscle groups in the experimental group supports the findings of Nguyen et al. (2022, p. 882), who demonstrated that PNF effectively reduces muscle hypertonicity through its emphasis on proprioceptive feedback and neuromuscular facilitation. For instance, the current study reported a reduction in MAS scores for left hip flexors (mean pre-treatment: 2.27, post-treatment: 1.64,  $p = 0.002$ ), which is comparable to Yeole et al. (2017, p. 381), who observed a similar degree of improvement in MAS scores after implementing rhythmic stabilization and contract-relax techniques.

In contrast, the control group showed statistically significant but less pronounced improvements, reflecting the limited efficacy of conventional physiotherapy in addressing spasticity. This finding resonates with Balasuburamaniam et al. (2020, p. 306), who noted that task-specific conventional therapies alone often fail to achieve the neuromuscular reorganization facilitated by PNF.

The Mann-Whitney U test results highlight the superiority of PNF in reducing spasticity compared to conventional therapy. For example, the left hip flexors in the experimental group had a significantly lower mean rank (7.50) compared to the control group (15.50,  $p = 0.001$ ). Similar trends were observed in studies such as Anandan et al. (2020, p. 306), where PNF outperformed traditional therapies in improving neuromuscular coordination. The observed statistical significance for most muscle groups further aligns with Sharma et al. (2017, p. 552), who emphasized the role of PNF in targeting specific neuromotor impairments post-stroke.

Interestingly, the lack of a significant difference for the left knee flexors in the current study ( $p = 0.069$ ) highlights variability in response, which has also been reported in smaller studies like those by (Kim et al. 2020, p. 521), where muscle-specific adaptations influenced therapy outcomes.

The substantial improvement in BBS scores within the experimental group (pre-treatment: 34.09, post-treatment: 48.00,  $p = 0.003$ ) underscores the efficacy of PNF in enhancing balance. This finding is consistent with Lee and Park (2020, p. 231), who demonstrated that PNF, through its integration of isotonic and rhythmic stabilization techniques, significantly improves postural stability and dynamic balance. The control group also showed improvement in BBS scores (pre-treatment: 35.09, post-treatment: 41.73,  $p = 0.003$ ); however, the magnitude of improvement was notably smaller, reaffirming the added benefit of PNF.

Comparing these findings with those of Choi and Ko (2020, p. 150), it is evident that PNF not only enhances proprioceptive input but also integrates functional movement patterns, leading to superior balance outcomes. This aligns with the current study's observation that participants in the experimental group achieved greater gains in BBS scores than the control group, reflecting the holistic approach of PNF in addressing balance impairments.

The Mann-Whitney U test results for BBS post-treatment scores further reinforce PNF's superior impact on balance. The experimental group had a significantly higher mean rank (16.41) compared to the control group (6.59,  $p = 0.001$ ). This aligns with findings by Rane et al. (2024), who reported that PNF-based interventions significantly outperformed traditional therapies in improving BBS scores among stroke patients. Such improvements are attributed to the neuromuscular re-education provided by PNF, which enhances coordination and stability.

In contrast, studies such as those by Barathi (2019, p. 201) observed that conventional therapies alone often plateau in their effectiveness, particularly in chronic stroke patients, highlighting the need for integrative approaches like PNF to achieve meaningful improvements in balance and mobility.

**Limitations:**

Also, the study included only 22 participants, which does not render enough basis to say that the results are applicable to a wider group of people. This would also support the findings if the sample size was bigger.

Post treatment outcome in the immediate period is emphasized with no long term follow up. It prevents the ability to look into the durability of the observed improvements over time.

As a result, the internal validity of the study was lowered if the participants were not randomly assigned to the experimental and control groups, which may have affected the study because of selection bias.

One important test instrument used in the study was mainly the Modified Ashworth Scale (MAS) and Berg Balance Scale (BBS) as tests for spasticity and balance respectively. By including other measures, such as gait analysis, functional independence, or quality of life, there would be more insight of the intervention effects.

The study was a population of homogenous participants (age, nutritional). That may limit the applicability of these findings to younger people or those with comorbidities.

However, in the case of measures such as MAS or BBS, which are subjective, bias from the observer may be a problem if the assessors were not blinded to group assignment.

The physiotherapy of the control group was conventional but not specified. If the variability of control group treatment is large, results may not be comparable.

It is possible that the PNF intervention in the experimental group may have induced a placebo effect because of the placebo of improvement applied.

This study explores the great potential of Proprioceptive Neuromuscular Facilitation as an effective rehabilitation approach to improve spasticity and balance in stroke patients. Using the Modified Ashworth Scale and Berg Balance Scale as primary outcome measures, the research has established that PNF-based interventions resulted in statistically significant reductions in muscle spasticity and notable improvements in balance compared to conventional physiotherapy. These findings emphasize the superiority of PNF in facilitating motor recovery and improving functional outcomes in stroke rehabilitation. The experimental group showed significant reductions in spasticity for all the assessed muscle groups, with most comparisons yielding p-values below 0.01. This would suggest that the emphasis on proprioceptive input and rhythmic stabilization in PNF serves to effectively reprogram neuromuscular pathways, a finding consistent with those from previous research, which has emphasized its role in reducing hypertonicity and promoting muscle relaxation. There were significant between-group differences, especially in the reduction of spasticity and enhancement of balance, as verified by the Mann-Whitney U test. The experimental group was consistently better compared to the control group with regard to lower mean ranks for spasticity and higher mean ranks for balance improvement. These findings provide strong evidence that PNF is not a supplementary intervention but a transformative approach that can address the complex nature of impairments following a stroke. However, further research is needed to confirm these findings in light of limitations like small sample size, short follow-up period, and limited diversity. In addition, the inclusion of wider functional and psychological outcomes would give a broader perspective on how PNF works in stroke rehabilitation. This study confirms the clinical usefulness of PNF as the cornerstone for the rehabilitation of stroke patients. It is a very important tool for clinicians because of its potential to greatly reduce spasticity, improve balance, and increase functional independence. Further studies will be required to establish long-term outcomes and optimization of PNF protocols to widen their application. These findings add to the growing evidence base that supports incorporating PNF into standard stroke rehabilitation protocols in an effort to improve patient outcomes and quality of life.

## **Recommendations**

Future studies are recommended to include a more diverse and larger sample of participants to increase the reliability and generalizability of the finding. This would create a larger sample so that more statistical power would be achieved and subgroup analyses would be based on age, gender or stroke severity. Future research should extend the duration of the intervention, longer than 3 months, and should be followed up with assessments. This way, information on the continued positive effects for balance, spasticity and overall functional recovery within PNF would be available. Expanding the study to aspects such as diverse geographic location, cultural backgrounds and balanced gender representation would lead to finding that the findings are more applicable to global stroke populations. It would also enable identification of demographic factors associated with rehabilitation outcomes. Double blind methodologies would entail use of double blind methodologies where both the participants and the assessor have no idea of the allocation of participants in groups, thus reducing observer and participant bias and improving accuracy and objectivity. Future studies should augment the use of wearable devices, digital platforms, and telehealth technologies to objectively track participant's adherence to home based exercises. They may create accurate intervention assessments based on real time tools of exercise frequency, intensity and compliance.

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## APPENDIX

SCMST-BPT/IRB/.....

To

MD.Saydur Rahman

4<sup>th</sup> Year Student of B.Sc. in Physiotherapy

Session:2018-2019 Reg No:10454

SAIC College of Medical Science & Technology (SCMST)

Mirpur-14, Dhaka-1216, Bangladesh

**Subject:** Approval of the thesis proposal "Evaluating the Effectiveness of PNF on Balance and Muscle tone in Stroke Patients: A Randomized Control Trial" by ethics committee.

MD.Saydur Rahman

Congratulations.

The Institutional Review Board (IRB) of SCMST 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:

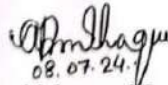
Sr. No.	Name of the Documents
1	Dissertation proposal
2	Questionnaire (English and Bangla version)
3	Information sheet & consent form.

The purpose of the study is to find out Evaluating the Effectiveness of PNF on Balance and Muscle tone in Stroke Patients: A Randomized Control Trial.

The study involves face to face interview by using semi-structured questionnaire to find out Evaluating the Effectiveness of PNF on Balance and Muscle tone in Stroke Patients: A Randomized Control Trial. that may take 30 to 40 minutes to fill in the questionnaire and there is no likelihood of any harm to the participants. The members of the ethics committee have approved the study to be conducted in the presented form at the meeting held at 09.00 AM on 28th September 2023 at SCMST.

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,



Dr. Abul Kasem Mohammad Enamul Haque  
Principal, SCMST & Chairman, Institutional Review Board (IRB)  
SAIC College of Medical Science & Technology (SCMST)

To

Unit Incharge .

Ibn sina D-Lab , Keraniganj

House: Maa Plaza, Kadamtoli Mor, Keraniganj, Dhaka-1310

**Subject: Prayer for permission to collect data from Ibn sina D-lab, Keraniganj to conduct a research project.**

Sir,

With due respect and humble submission to state that I am a student of B.Sc. in Physiotherapy at SAIC College of Medical Science and Technology, Mirpur-14, Dhaka. As a part of our course curriculum, we must conduct a research project for the degree of B.Sc. in Physiotherapy. My research title is "Evaluating the Effectiveness of PNF on Balance and Muscle tone in Stroke Patients" and the study aims to assess the comparative effectiveness of PNF and usual physiotherapy in reducing muscle tone and improving balance among patients with stroke. This is a randomized controlled trial under the supervision of Dr. Ehsanur Rahman Assistant Professor of Physiotherapy and Rehabilitation at Jashore University of Science and Technology. I have chosen The IBN Sina Trust as a site for data collection.

So, I, therefore, pray and hope that you would be kind enough to permit data collection that will help me to complete my study.

Yours Faithfully

Saydur Rahman  
Student of B.Sc. in Physiotherapy  
Session: 2018 -2019  
Reg No: 10454

SAIC College of Medical Science and Technology (SCMST)  
Mirpur-14, Dhaka 1216, Bangladesh.  
04-07-2024

*Azizulki*  
*24-07-2024*  
Wazed Arif Siddiki  
Unit Incharge  
Ibn Sina D-Lab, Keraniganj

To

Unit Incharge ,

Ibn sina D-Lab , Uttara.

HOUSE # 52,GARIB-E-NEWAZ AVENUE,SECTION-13, UTTARA,DHAKA-1230.

**Subject: Prayer for permission to collect data from Ibn sina D-lab, UTTARA to conduct a research project.**

Sir,

With due respect and humble submission to state that I am a student of B.Sc. in Physiotherapy at SAIC College of Medical Science and Technology, Mirpur-14, Dhaka. As a part of our course curriculum, we must conduct a research project for the degree of B.Sc. in Physiotherapy. My research title is "Evaluating the Effectiveness of PNF on Balance and Muscle tone in Stroke Patients" and the study aims to assess the comparative effectiveness of PNF and usual physiotherapy in reducing muscle tone and improving balance among patients with stroke. This is a randomized controlled trial under the supervision of Dr. Ehsanur Rahman Assistant Professor of Physiotherapy and Rehabilitation at Jashore University of Science and Technology. I have chosen The IBN Sina Trust as a site for data collection.

So, I therefore, pray and hope that you would be kind enough to permit data collection that will help me to complete my study.

Yours Faithfully

Saydur Rahman  
Student of B.Sc. in Physiotherapy  
Session: 2018 -2019  
Reg No: 10454

SAIC College of Medical Science and Technology (SCMST)  
Mirpur-14, Dhaka 1216, Bangladesh.  
04-07-2024

21.7.2024  
MD. Omar Faruq  
Senior Physiotherapist  
Department Incharge  
IBN SINA Diagnostic  
And Consultation Center  
Uttara, Dhaka-1230.

**সম্মতিপত্র) বাংলা(**  
**অনুগ্রহ করে মনযোগ দিয়ে পড়ুন**

আসসালামুয়ালাইকুম!

আমি মোঃ সাইদুর রহমান, বি এস সি ফিজিওথেরাপিতে, ৪র্থ বর্ষ ২০১৮-১৯ সেশন, মেডিসিন অনুষদের অধীনে ঢাকা বিশ্ববিদ্যালয়ের অধিভুক্ত সাইক কলেজ অফ মেডিকেল সায়েন্স অ্যান্ড টেকনোলজিতে পড়াশোনা করছি। আমি একটি গবেষণা প্রোগ্রাম পরিচালনা করছি যার শিরোনাম "স্ট্রোক রোগীদের পেশীর টোন এবং ভারসাম্যের উপর পিএনএফ এর কার্যকারিতা মূল্যায়ন : একটি রেন্ডমাইজড কন্ট্রোল ট্রায়াল"। এই গবেষণায়, আমি স্ট্রোক রোগীদের পেশীর টোন এবং ভারসাম্যের উপর পিএনএফ এর কার্যকারিতা মূল্যায়ন করতে চাই। আমি আপনার সামাজিক জনসংখ্যা সংক্রান্ত কিছু তথ্যের অনুরোধ করতে চাই, এবং চিকিৎসা সংক্রান্ত তথ্য-সম্পর্কিত প্রশ্না অনুগ্রহ করে মনে রাখবেন যে এই একাডেমিক গবেষণা সাক্ষাত্কারটি সম্পূর্ণ হতে প্রায় ২০-৩০ মিনিট সময় লাগবে। এই গবেষণায় অংশগ্রহণ করা আপনার বর্তমান বা ভবিষ্যতের চিকিৎসাকে কোনোভাবেই প্রভাবিত করবে না। এটি উল্লেখ করা গুরুত্বপূর্ণ যে সংগৃহীত তথ্য শুধুমাত্র একাডেমিক গবেষণার উদ্দেশ্যে ব্যবহার করা হবে, এবং আপনার দেওয়া সমস্ত তথ্য গোপন রাখা হবে। কোনো প্রতিবেদন বা প্রকাশনার ক্ষেত্রে, আমরা নিশ্চিত করব যে আপনার পরিচয় গোপন থাকবে। এই গবেষণায় আপনার অংশগ্রহণ স্বৈচ্ছায়, এবং আপনি এই গবেষণা চলাকালীন যেকোনো সময় কোনো নেতিবাচক পরিণতি ছাড়াই প্রত্যাহার করতে পারেন। সাক্ষাত্কারের সময় আপনি পছন্দ করেন না বা উত্তর দিতে চান না এমন প্রশ্নের উত্তর না দেওয়ার অধিকারও আপনার আছে।

অধ্যয়ন বা অংশগ্রহণকারী হিসাবে আপনার অধিকার সম্পর্কে আপনার কোন প্রশ্ন থাকলে, অনুগ্রহ করে তদন্তকারী মোঃ সাইদুর রহমান, অথবা গবেষণা তত্ত্বাবধায়ক ডাঃ, এহসানুর রহমান, ফিজিওথেরাপি এবং পুনর্বাসন বিভাগের সহকারী অধ্যাপক, যশোর বিজ্ঞান ও প্রযুক্তি বিশ্ববিদ্যালয়ের সাথে যোগাযোগ করুন।

ইন্টারভিউ শুরু করার আগে কি আপনার কোন প্রশ্ন আছে?

তাহলে, ইন্টারভিউ নিয়ে এগিয়ে যেতে আমি কি আপনার সম্মতি পেতে পারি?

হ্যাঁ		না	
হ্যাঁ		না	

অংশগ্রহণকারীর স্বাক্ষর

.....

ইন্টারভিউয়ারের স্বাক্ষর

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তারিখ

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তারিখ

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শিরোনাম: "স্ট্রোক রোগীদের পেশীর টোন এবং ভারসাম্যের উপর পিএনএফ এর কার্যকারিতা মূল্যায়ন :একটি  
রেভাইজড কন্ট্রোল ট্রায়াল"

অংশ ১: ব্যক্তিগত তথ্য			
১.১	রোগীর আইডি:		
১.২	ইন্টারভিউয়ের তারিখ:		
১.৩	অংশগ্রহণকারীর নাম:		
১.৪	কোড:		
১.৫	ঠিকানা:	গ্রাম:	পোস্ট অফিস:
		উপজেলা:	জেলা:
১.৬	ফোন		
অংশ ২: রোগীর সামাজিক জন-তাত্ত্বিক তথ্য (সঠিক উত্তরে টিক (✓) চিহ্ন দিন)			
ক্রমিক নং	প্রশ্ন	উত্তর	
২.১	বয়স:	[ ] বছর	
২.২	লিঙ্গ:	(০) পুরুষ	(১) নারী
২.৩	বৈবাহিক অবস্থা:	(০) বিবাহিত	(১) অবিবাহিত
২.৪	পরিবারের ধরন:	(০) একক পরিবার	(১) যৌথ পরিবার
২.৫	বসবাসের স্থান:	(০) শহর	(১) গ্রাম
২.৬	শিক্ষাগত যোগ্যতা:	(০) অশিক্ষিত	(১) প্রাথমিক
		(২) মাধ্যমিক	(৩) উচ্চ মাধ্যমিক
২.৭	পেশা:	(৪) স্নাতক	(৫) স্নাতকোত্তর
		(০) বেকার	(১) দিনমজুর
২.৮	পরিবারের উপার্জনক্ষম সদস্য সংখ্যা	(২) চাকুরী	(৩) কৃষক
		(৪) খেলোয়াড়	(৫) অন্যান্য
অংশ ৩: মেডিকেল তথ্য			
৩.১	উচ্চতা	[ ] সেমি	
৩.২	ওজন	[ ] কেজি	

৩.৩	বি এম আই	(০) কম ওজন	(১) স্বাভাবিক ওজন
		(২) বেশি ওজন	(২) স্থূল

অংশ ৪; স্ট্রোকজনিত তথ্য			
ক্রমিক নং	প্রশ্ন	উত্তর	
৪.১	স্ট্রোকের ঘটনার তারিখ	তারিখ/মাস/বছর.....	
৪.২	আক্রান্ত পাশ	(০) ডান	(১) বাম (২) উভয়
৪.৩	স্ট্রোকের ধরন	(০) ইস্কেমিক	(১) রক্তক্ষরণজনিত
৪.৪	স্ট্রোকের সময়কাল	(০) < ৩ মাসের কম	(১) > ৩ মাসের বেশি (২) ৬ মাসের বেশি
		(৩) ১ বছরের বেশি	(৪) ২ বছরের বেশি
৪.৫	আপনি কতটি ফিজিওথেরাপী চিকিৎসা পেয়েছেন?	(০) ১-২ সেশন	(১) ৩-৪ সেশন (২) ৫-৬ সেশন
		(৩) ৭-৮ সেশন	(৪) > ৮ সেশন
৪.৬	ধূমপান অভ্যাস	(০) হ্যাঁ	(১) না

### পার্ট-৫ঃ বার্গ-ব্যালেন্স স্কোর দ্বারা ভারসাম্যের মূল্যায়ন

এই প্রশ্নাবলী স্ট্রোক রোগীদের জন্য তাদের স্ট্যাটিক এবং গতিশীল ভারসাম্য মূল্যায়ন করার জন্য ডিজাইন করা হয়েছে। বার্গ ব্যালেন্স স্কোর হল একটি সাধারণভাবে ব্যবহৃত ক্লিনিকাল মূল্যায়ন যা একজন ব্যক্তির স্ট্যাটিক এবং গতিশীল ভারসাম্য বজায় রাখার ক্ষমতা মূল্যায়ন করে। এটি ক্যাথরিন বার্গের জন্য নামকরণ করা হয়েছে, এটির বিকাশে অবদানকারীদের একজন ১৪ টি আইটেমের এই স্কোর একটি পরিমাণগত ভারসাম্য মূল্যায়ন প্রদান করে। আইটেমগুলি ০ থেকে ৪ পর্যন্ত একটি স্কেলে মূল্যায়ন করা হয়, যেখানে ০ এর স্কোর কার্য সম্পাদনে অক্ষমতা নির্দেশ করে এবং ৪ এর স্কোর সহায়তা ছাড়াই কার্যকলাপের সফল সমাপ্তি নির্দেশ করে। সর্বাধিক ৫৬টি অর্জনযোগ্য পয়েন্টের উপর ভিত্তি করে একটি ক্রমবর্ধমান স্কোর গণনা করা হয়। ফিজিওথেরাপিস্ট একটি বলপয়েন্ট কলম ব্যবহার করে এই প্রশ্নাবলীর উপাদানটি সম্পূর্ণ করবেন যা হয় কালো বা নীল রঙের।

[সঠিক উত্তর চিহ্নিত করতে টিক(✓) ব্যবহার করুন]

নং	কার্যকলাপ	পরীক্ষার আগের স্কোর	পরীক্ষার পরের স্কোর
৫.১	বসা থেকে দাঁড়ানো (আপনার হাতের সাহায্য ছাড়া চেষ্টা করুন) ৪= হাত ব্যবহার না করে দাঁড়াতে এবং নিজে নিজে ভারসাম্য রাখতে পারে। ৩= হাত ব্যবহার করে ভারসাম্য রাখতে পারে। ২= বেশ কয়েকবার চেষ্টা করে ভারসাম্য রাখতে পারে। ১= দাঁড়াতে বা স্থিতিশীল হতে ন্যূনতম সহায়তা প্রয়োজন। ০= দাঁড়াতে মাঝারি বা সর্বাধিক সহায়তা প্রয়োজন।		

৫.২	<p>সাহায্য ছাড়া দাঁড়ানো (২ মিনিট)</p> <p>৪= ২ মিনিট নিরাপদে দাঁড়াতে সক্ষম।</p> <p>৩= পর্যবেক্ষণ ও দেখাশুনার মাধ্যমে ২ মিনিট দাঁড়াতে সক্ষম।</p> <p>২= ৩০ সেকেন্ড দাঁড়াতে সক্ষম।</p> <p>১= বেশ কয়েকবার চেঁচার পর ৩০ সেকেন্ড দাঁড়াতে সক্ষম।</p> <p>০= ৩০ সেকেন্ড দাঁড়াতে অক্ষম।</p>		
৫.৩	<p>সাহায্য ছাড়া বসা (পিঠে সাহায্য ছাড়া এবং পা টুলের উপরে রেখে)</p> <p>৪= ২ মিনিটের জন্য নিরাপদে বসতে সক্ষম।</p> <p>৩= পর্যবেক্ষণ ও দেখাশুনার মাধ্যমে ২ মিনিট বসতে সক্ষম।</p> <p>২= ৩০ সেকেন্ড বসতে সক্ষম।</p> <p>১= ১০ সেকেন্ড বসতে সক্ষম।</p> <p>০= ১০ সেকেন্ড সাহায্য ছাড়া বসতে অক্ষম।</p>		
৫.৪	<p>দাঁড়ানো থেকে বসা</p> <p>৪= হাতের কিছুটা সাহায্য নিয়ে বসতে পারে।</p> <p>৩= হাতের সাহায্য নিয়ে নিচে পড়ে যাওয়া নিয়ন্ত্রণ করতে পারে।</p> <p>২= পায়ের পিছন দিক ব্যবহার করে নিচে পরে যাওয়া নিয়ন্ত্রণ করতে পারে।</p> <p>১= নিজে নিজে বসতে পারে কিন্তু নিচে পড়ে যাওয়া নিয়ন্ত্রণ করতে পারে না।</p> <p>০= বসতে সাহায্য লাগে।</p>		
৫.৫	<p>স্থানান্তর (স্থানান্তরের জন্য চেয়ার বা বিছানা ব্যবহার করণ)</p> <p>৪= হাতের সামান্য ব্যবহার করে নিরাপদ স্থানে বসতে সক্ষম।</p> <p>৩= হাতের যথাযথ ব্যবহার করে নিরাপদ স্থানে বসতে সক্ষম।</p> <p>২= মৌখিক ইঙ্গিত দ্বারা স্থানান্তর করতে সক্ষম।</p> <p>১= স্থানান্তরের জন্য একজন ব্যক্তি প্রয়োজন।</p> <p>০= নিরাপদে স্থানান্তরের জন্য দুইজন ব্যক্তি প্রয়োজন।</p>		
৫.৬	<p>চোখ বন্ধ করে দাঁড়ানো (১০ সেকেন্ড দাঁড়িয়ে থাকা)</p> <p>৪= ১০ সেকেন্ড নিরাপদে দাঁড়াতে সক্ষম।</p> <p>৩= পর্যবেক্ষণ ও দেখাশুনার মাধ্যমে ১০ সেকেন্ড দাঁড়াতে সক্ষম।</p> <p>২= ৩ সেকেন্ড দাঁড়াতে সক্ষম।</p> <p>১= ৩ সেকেন্ড চোখ বন্ধ করে দাঁড়াতে অক্ষম কিন্তু নিরাপদে দাঁড়িয়ে থাকতে পারে।</p> <p>০= পড়ে যাওয়া রোধ করতে সাহায্যের প্রয়োজন।</p>		
৫.৭	<p>দুই পা একসাথে করে দাঁড়ানো (আপনার পা একসাথে রেখে সাহায্য ছাড়া দাঁড়িয়ে থাকুন)</p> <p>৪= নিজে নিজে পা রেখে নিরাপদে ১ মিনিট দাঁড়াতে সক্ষম।</p> <p>৩= নিজে নিজে পা রেখে নিরাপদে ১ মিনিট দাঁড়াতে সক্ষম কিন্তু পর্যবেক্ষণ প্রয়োজন।</p> <p>২= অবস্থান ঠিক রাখতে পারে কিন্তু ৩০ সেকেন্ড এর বেশি বা একসাথে রাখতে অক্ষম।</p> <p>০= অবস্থান ঠিক রাখতে সাহায্য প্রয়োজন কিন্তু ১৫ সেকেন্ড পা একসাথে রাখতে পর্যবেক্ষণ প্রয়োজন।</p>		
৫.৮	<p>হাত দিয়ে দূরবর্তী জিনিস ধরা (বাহু ৯০° উঠান এবং হাত সামনে বাড়িয়ে দিন)</p> <p>৪= আত্মবিশ্বাসের সাথে ২৫ সেমি এগিয়ে যেতে পারে।</p> <p>৩= ১২ সেমি এগিয়ে যেতে পারে।</p> <p>২= ৫ সেমি এগিয়ে যেতে পারে।</p>		

	<p>১= সামনে পৌঁছাতে পারে কিন্তু পর্যবেক্ষনের প্রয়োজন।</p> <p>০= সামনে এগিয়ে যাওয়ার সময় ভারসাম্য হারায়।</p>		
৫.৯	<p>মেঝে থেকে জিনিস তোলা (জুতা তুলে নিন যা আপনার পায়ের সামনে আছে)</p> <p>৪= নিরাপদে ও সহজেই জুতা তুলে নিতে পারে।</p> <p>৩= জুতা তুলতে সক্ষম কিন্তু পর্যবেক্ষণের প্রয়োজন।</p> <p>২= তুলতে অক্ষম কিন্তু স্লিপার থেকে ২-৫ সেমি সামনে চলে যায় কিন্তু ভারসাম্য ধরে রাখতে পারে।</p> <p>১= তুলতে অক্ষম কিন্তু ভারসাম্য রাখতে পর্যবেক্ষণ প্রয়োজন।</p> <p>০= চেষ্টা করতে অক্ষম এবং ভারসাম্য হারায়।</p>		
৫.১০	<p>পিছনে ঘুরে তাকানো (বাম দিকে ঘুরে তাকান। ডান দিকে পুনরাবৃত্তি করুন)</p> <p>৪= উভয়পাশ থেকে ভালোভাবে তাকাতে পারে এবং সমান ওজন বিনিময় করতে পারে।</p> <p>৩= একপাশে তাকাতে পারে এবং একদিকে কম ওজন বিনিময় করতে পারে।</p> <p>২= একপাশে তাকাতে পারে কিন্তু ভারসাম্য রাখতে পারে না।</p> <p>১= ঘুরে যাবার সময় পর্যবেক্ষণ প্রয়োজন হয়।</p> <p>০= ঘুরে যাবার সময় পড়ে যাওয়া রোধ করতে সাহায্যের প্রয়োজন হয়।</p>		
৫.১১	<p>৩৬০° ডিগ্রী ঘুরে যাওয়া (একটি পূর্ণ বৃত্ত ঘুরান এবং বিপরীত দিক থেকে চেষ্টা করুন)</p> <p>৪= ৪ সেকেন্ড বা তার কম সময়ে ৩৬০° ডিগ্রী ঘুরতে সক্ষম।</p> <p>৩= ৪ সেকেন্ড বা তার কম সময়ে ৩৬০° ডিগ্রী নিরাপদে শুধুমাত্র একদিক থেকে ঘুরতে সক্ষম।</p> <p>২= নিরাপদে ধীরে ধীরে ৩৬০° ডিগ্রী ঘুরতে সক্ষম।</p> <p>১= মৌখিক ইঙ্গিত প্রয়োজন।</p> <p>০= ঘুরার সময় সাহায্য প্রয়োজন।</p>		
৫.১২	<p>টুলের ওপর বিপরীত পা রাখা (দুই পা দিয়ে অন্তত চারবার চেষ্টা করুন)</p> <p>৪= স্বাধীনভাবে এবং নিরাপদে দাড়াতে এবং ২০ সেকেন্ডের মধ্যে ৮ টি ধাপ সম্পন্ন করতে পারে।</p> <p>৩= স্বাধীনভাবে এবং নিরাপদে দাড়াতে এবং ২০ সেকেন্ডের অধিক সময়ের মধ্যে ৮ টি ধাপ সম্পন্ন করতে পারে।</p> <p>২= পর্যবেক্ষণ ছাড়াই ৪ টি ধাপ সম্পূর্ণ করতে পারে।</p> <p>১= কিছুটা সাহায্য দ্বারা ২ টির কম পদক্ষেপ দিতে পারে।</p> <p>০= পড়ে যাওয়া থেকে রক্ষা পেতে সাহায্য প্রয়োজন।</p>		
৫.১৩	<p>সামনে এক পা দিয়ে দাঁড়ানো</p> <p>৪= স্বাধীনভাবে একপা সামনে দিয়ে দাড়াতে পারে এবং বিপরীত পা দিয়ে সমান ভাবে পারে এবং ৩০ সেকেন্ড ধরে রাখতে পারে।</p> <p>৩= স্বাধীনভাবে একপা সামনে দিয়ে দাড়াতে পারে এবং বিপরীত পা দিয়ে সমান ভাবে পারে না এবং ৩০ সেকেন্ড ধরে রাখতে পারে।</p> <p>২= পদক্ষেপের জন্য সাহায্যের প্রয়োজন কিন্তু ৩০ সেকেন্ড ধরে রাখতে পারে।</p> <p>১= পদক্ষেপের জন্য সাহায্যের প্রয়োজন কিন্তু ১৫ সেকেন্ড ধরে রাখতে পারে।</p> <p>০= পদক্ষেপ বা দাঁড়ানোর সময় ভারসাম্য রাখতে পারে না।</p>		

৫.১৪	<p>এক পায়ে দাঁড়ানো (যতক্ষণ আপনি পারেন এক পায়ে দাঁড়িয়ে থাকুন ধরে না রেখে)</p> <p>৪= স্বাধীনভাবে পা তুলতে পারে এবং ১০ সেকেন্ড এর বেশি সময় ধরে রাখতে পারে।</p> <p>৩= স্বাধীনভাবে পা তুলতে পারে এবং ৫-১০ সেকেন্ড এর বেশি সময় ধরে রাখতে পারে।</p> <p>২= স্বাধীনভাবে পা তুলতে পারে এবং ৩ সেকেন্ড বা এর কম সময় ধরে রাখতে পারে।</p> <p>১= স্বাধীনভাবে পা তুলতে পারে এবং ৩ সেকেন্ড ধরে রাখতে পারে না কিন্তু স্বাধীনভাবে দাঁড়িয়ে থাকতে পারে।</p> <p>০= পড়ে যাওয়া থেকে রক্ষা পেতে সাহায্য প্রয়োজন।</p>		
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মোট পরীক্ষা স্কার:

তারিখঃ .....

পরীক্ষকের স্বাক্ষরঃ.....

মোডিফাইড এশওয়ারথ স্কেল

**সাধারণ তথ্য) বোহানন এবং স্মিথ থেকে প্রাপ্ত, ১৯৮৭:(**

১. সুপাইন অবস্থায় রোগী

২. যদি একটি পেশী পরীক্ষা করা হয় যা প্রাথমিকভাবে একটি জয়েন্টকে ফ্লেক্স করে, জয়েন্টটিকে সর্বাধিক নমনীয় অবস্থানে রাখুন এবং এক সেকেন্ডের মধ্যে সর্বাধিক বর্ধনের অবস্থানে যান) গণনা" এক হাজার এক("

৩. যদি একটি পেশী পরীক্ষা করা হয় যা প্রাথমিকভাবে একটি জয়েন্টকে প্রসারিত করে, জয়েন্টটিকে সর্বাধিক প্রসারিত অবস্থানে রাখুন এবং এক সেকেন্ডের বেশি বাঁকানো অবস্থানে যান) গণনা" এক হাজার এক("

৪. নীচের শ্রেণীবিভাগের উপর ভিত্তি করে স্কের

**স্কেরিং) বোহানন এবং স্মিথ থেকে নেওয়া, ১৯৮৭:(**

০	পেশী স্বন বৃদ্ধি নেই
১	পেশীর স্বরে সামান্য বৃদ্ধি, ক্যাচ এবং রিলিজ দ্বারা বা গতির সীমার শেষে ন্যূনতম প্রতিরোধের দ্বারা উদ্ভাসিত হয় যখন প্রভাবিত অংশ)গুলি (বাঁক বা এক্সটেনশনে সরানো হয়
১+	পেশীর স্বরে সামান্য বৃদ্ধি, একটি ক্যাচ দ্বারা উদ্ভাসিত, এর পরে রমের অবশিষ্টাংশ) অর্ধেকেরও কম (জুড়ে ন্যূনতম প্রতিরোধ।
২	বেশির ভাগ ROM-এর মাধ্যমে পেশীর স্বরে আরও লক্ষণীয় বৃদ্ধি, কিন্তু প্রভাবিত অংশ)গুলি (সহজেই সরে যায়
৩	পেশী স্বন যথেষ্ট বৃদ্ধি, নিষ্ক্রিয় আন্দোলন কঠিন
৪	প্রভাবিত অংশ)গুলি (বাঁক বা এক্সটেনশনে অনমনীয়

**রোগীর নির্দেশাবলী:**

রোগীকে শিখিল হতে নির্দেশ দেওয়া উচিত

সংশোধিত অ্যাশওয়ার্থ স্কেল টেস্টিং ফর্ম

নাম: \_\_\_\_\_ তারিখ: \_\_\_\_\_

পরিক্ষিত মাংসপেশি	পরীক্ষার আগের স্কোর	পরীক্ষার পরের স্কোর

**Reference for test instructions:**

Bohannon, R. and Smith, M. (১৯৮৭). "Interrater reliability of a modified Ashworth scale of muscle spasticity." Physical Therapy ৬৭(২): ২০৬.

**CONSENT STATEMENT (English)**  
**Please Read It Carefully**

Assalamualaikum!

I am Md. Saydur Rahman, a student of B.Sc. in physiotherapy, 4th year 2018-19 session, at Saic College of Medical Science & Technology, affiliated with the University of Dhaka under the faculty of Medicine. I am conducting a research program entitled “Evaluating the Effectiveness of PNF on Quality of Life, Gait, and Balance in Stroke Patients: A Randomized Control Trial”. In this study, I would like to evaluate the effectiveness of PNF on quality of life, gait and balance of stroke patients. I would like to request some information regarding your sociodemographic, and medical information-related questions. Please note that this academic research interview will take approximately 20-30 minutes to complete. Participating in this study will not affect your current or future treatment in any way. It is important to mention that the information collected will only be used for academic research purposes, and all your provided data will be kept confidential. In the case of any report or publication, we will ensure that your identity remains anonymous.

Your participation in this study is voluntary, and you may withdraw at any time during this study without any negative consequences. You also have the right not to answer a question you don’t like or do not want to answer during the interview.

If you have any questions regarding the study or your rights as a participant, please feel free to contact the investigator Md. Saydur Rahman, or the research supervisor Dr, Ehsanur Rahman, Assistant Professor of physiotherapy and rehabilitation, Jashore University of Science and Technology

Do you have any questions before I start?

Yes		No	
Yes		No	

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

Signature of Participant  
.....

Date.....

Signature of Interviewer  
.....

Date.....

**Title: “Evaluating the Effectiveness of PNF on Quality of Life, Gait, and Balance in Stroke Patients: A Randomized Control Trial”**

<b>Part 1: Personal information</b>			
1.1	<b>Patient ID:</b>		
1.2	<b>Date of Test:</b>		
1.3	<b>Name of participant:</b>		
1.4	<b>Code:</b>		
1.5	<b>Address:</b>	<b>Village:</b>	<b>Post-office:</b>
		<b>Upazilla:</b>	<b>District:</b>
1.6	<b>Phone</b>		
<b>Part 2- Patient’s Socio-demographic information</b>			
(Please give a tick (√) mark on the left side of the correct answer)			
SL No	Questions	Responses	
2.1	<b>Age:</b>	[                    ] Years	
2.2	<b>Gender:</b>	(0) Male	(1) Female
2.3	<b>Marital status:</b>	(0) Married	(1) Unmarried
2.4	<b>Family type:</b>	(0) Nuclear Family	(1) Joint Family
2.5	<b>Living area:</b>	(0) Urban	(1) Rural
2.6	<b>Educational Qualification:</b>	(0) Illiterate	(1) Primary
		(2) Secondary	(3) Higher Secondary
2.7	<b>Occupation:</b>	(4) Bachelor	(5) Masters
		(0) Unemployed	(1) Day labor
2.8	<b>Number of Earning members</b>	(2) Desk job	(3) Farmer
		(4) Athlete	(5) Others
<b>Part 3: Medical information</b>			
3.1	<b>Height</b>	[                    ] cm	
3.2	<b>Weight</b>	[                    ] kg	
3.3	<b>BMI</b>	(0) Underweight	(1) Normal weight
		(2) Overweight	(2) Obese

<b>Part-4: Stroke Related Information</b>				
SL No	Question	Response of Participants		
4.1	Date of incidence	DD	MM	YEAR
4.2	Affected side	(0) Right	(1) Left	(2) Both
4.3	Type of stroke	(0) Ischemic	(1) Hemorrhagic	
4.4	Duration of stroke	(0) < than 3 month	(1) > than 3 month	(2) > than 6 month
		(3) > than 1 year		(4) > than 2 year
4.5	How many sessions of physiotherapy treatment have you received?	(0) 1-2 session	(1) 3-4 session	(2) 5-6 session
		(3) 7-8 session		(4) > 8 session
4.6	Smoking / Tobacco Habit	(0) Yes	(1) No	

### **Part 5: Assessment of balance by Burg Balance Scale(BBS)**

[Tick ✓ the point, which is able to perform patient]

No.	INSTRUCTIONS	Pre-test Score	Post-test Score
2.1	<p><b>STANDING FROM SITTING</b> (Try not to use your hand for support)</p> <p>4= Able to stand without using hands and stabilize independently</p> <p>3= Able to stand independently using hands</p> <p>2= Able to stand using hands after several tries</p> <p>1= Needs minimal aid to stand or stabilize</p> <p>0= Needs moderate or maximal assistance to stand</p>		
2.2	<p><b>STANDING UNSUPPORTED</b></p> <p>Please stand for two minutes without holding on</p> <p>4= Able to stand safely for 2 minutes</p> <p>3= Able to stand for 2 minutes with supervision</p> <p>2= Able to stand 30 seconds unsupported</p> <p>1= Needs several tries to stand 30 seconds unsupported</p> <p>0= Unable to stand 30 seconds unsupported</p> <p>If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported.</p> <p>Proceed to item #4.</p>		
2.3	<p><b>SITTING WITH BACK UNSUPPORTED</b> (Feet Supported On the Floor Or On A Stool)</p> <p>4= Able to sit safely and securely for 2 minutes</p> <p>3= Able to sit for 2 minutes under supervision</p>		

	<p>2= Able to sit for 30 seconds  1= Able to sit for 10 seconds  0= Unable to sit without support 10 seconds</p>		
<b>2.4</b>	<p><b>STANDING TO SITTING</b>  4= Sits safely with minimal use of hands  3= Controls descent by using hands  2= Uses the back of legs against the chair to control the descent  1= Sits independently but has uncontrolled descent  0= Needs assist to sit</p>		
<b>2.5</b>	<p><b>TRANSFERS</b>  Arrange a chair for pivot transfer. Ask the subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use a bed and a chair.  4= Able to transfer safely with minor use of hands  3= Able to transfer safely definite need of hands  2= Able to transfer with verbal cueing and/or supervision  1= Needs one person to assist  0= Needs two people to assist or supervise to be safe</p>		
<b>2.6</b>	<p><b>STANDING UNSUPPORTED WITH EYES CLOSED</b>  <b>(Please close your eyes and stand still for 10 seconds.)</b>  4= Able to stand for 10 seconds safely  3= Able to stand for 10 seconds with supervision  2= Able to stand 3 seconds  1= Unable to keep eyes closed for 3 seconds but stays safely  0= Needs help to keep from falling</p>		
<b>2.7</b>	<p><b>STANDING UNSUPPORTED WITH FEET TOGETHER</b>  <b>(Place your feet together and stand without holding on.)</b>  4= Able to place feet together independently and stand 1 minute safely  3= Able to place feet together independently and stand 1 minute with supervision  2= Able to place feet together independently but unable to hold for 30 seconds  1= Needs help to attain position but able to stand 15 seconds feet together  0= Needs help to attain position and unable to hold for 15 seconds</p>		
<b>2.8</b>	<p><b>REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING INSTRUCTIONS</b>  Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Ask the 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)</p>		

	<p>1= Reaches forward but needs supervision 0= Loses balance while trying/requires external support</p>		
<b>2.9</b>	<p><b>PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION</b> Pick up the shoe/slipper, which is placed in front of your feet. 4= Able to pick up slippers safely and easily 3= Able to pick up slipper but needs supervision 2= Unable to pick up but reaches 2-5 cm from slipper and keeps balance independently 1= Unable to pick up and needs supervision while trying 0= Unable to try/needs assistance to keep from losing balance or falling</p>		
<b>2.10</b>	<p><b>TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING</b> Turn to look directly behind you over toward the left shoulder. Repeat to the right. The 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 the other side shows less weight shift 2= Turns sideways only but maintains balance 1= Needs supervision when turning 0= Needs assistance to keep from losing balance or falling</p>		
<b>2.11</b>	<p><b>TURN 360 DEGREES</b> 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 on one side in only 4 seconds or less 2= Able to turn 360 degrees safely but slowly 1= Needs close supervision or verbal cueing 0= Needs assistance while turning</p>		
<b>2.12</b>	<p><b>PLACE ALTERNATE FOOT ON THE STEP OR STOOL WHILE STANDING UNSUPPORTED</b> Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times 4= Able to stand independently and safely and complete 8 steps in 20 seconds 3= Able to stand independently and complete 8 steps in &gt; 20 seconds 2= Able to complete 4 steps without aid with supervision 1= Able to complete &gt; 2 steps need minimal assist 0= Needs assistance to keep from falling/unable to try</p>		
<b>2.13</b>	<p><b>STANDING UNSUPPORTED ONE FOOT IN FRONT</b> 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 for 30 seconds</p>		

	3= Able to place foot ahead independently and hold for 30 seconds 2= Able to take small steps independently and hold for 30 seconds 1= Needs help to step but can hold for 15 seconds 0= Loses balance while stepping or standing		
<b>2.14</b>	<b>STANDING ON ONE LEG</b> Stand on one leg as long as you can without holding on. 4= Able to lift leg independently and hold > 10 seconds 3= Able to lift leg independently and hold for 5-10 seconds 2= Able to lift leg independently and hold ≥ 3 seconds 1= Tries to lift leg unable to hold 3 seconds but remains standing independently 0= Unable to try or needs assistance to prevent fall		

**Total Score:**

Date: ..... Signature of Examiner.....

## Modified Ashworth Scale Instructions

### **General Information (derived Bohannon and Smith, 1987):**

1. The patient in a supine position
2. If testing a muscle that primarily flexes a joint, place the joint in a maximally flexed position and move to a position of maximal extension over one second (count “one thousand one”)
3. If testing a muscle that primarily extends a joint, place the joint in a maximally extended position and move to a position of maximal flexion over one second (count “one thousand one”)
4. Score based on the classification below

### **Scoring (taken from Bohannon and Smith, 1987):**

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

### **Patient Instructions:**

The patient should be instructed to relax

## Modified Ashworth Scale Testing Form

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Muscle Tested	Pre-test Score	Post-test Score

**Gant Chart**

<b>Activities/ months</b>	<b>Sep 23</b>	<b>Oct 23</b>	<b>Nov 23</b>	<b>Dec 23</b>	<b>Jan 24</b>	<b>Feb 24</b>	<b>Mar 24</b>	<b>Apr 24</b>	<b>May 24</b>	<b>June 24</b>	<b>July 24</b>	<b>Aug 24</b>
<b>Proposal presentation</b>												
<b>Introduction</b>												
<b>Literature review</b>												
<b>Methodology</b>												
<b>Data collection</b>												
<b>Data Analysis</b>												
<b>Result</b>												
<b>1<sup>st</sup> progress presentation</b>												
<b>Discussion</b>												
<b>Conclusion And Recommendation</b>												
<b>2<sup>nd</sup> progress presentation</b>												
<b>Communication with supervisor</b>												
<b>Final submission</b>												