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Effects of Electric Functional Stimulation on tibialis Anterior for Dorsiflexion Among the Patient with Guillain Barre Syndrome

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LIST OF ACRONYMS

EFS:	Electric Functional Stimulation
OGS:	Oxford Grading Scale
BHPI:	Bangladesh Health Professions Institute
BMI:	Body mass index
BMRC:	Bangladesh Medical & Research Council
CM:	Centimeter
CRP:	Centre for the Rehabilitation of the Paralysed
DM:	Diabetes Mellitus
HTN:	Hypertension
IRB:	Institutional Review Board
KG:	Kilogram
SCMST:	Saic College of Medical Science and Technology
WHO:	World Health Organization
WT:	Weight
10 MWT:	10 Meter Walk Test

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ABSTRACT

Background: Guillain-Barre Syndrome (GBS) is an acute, immune-mediated polyneuropathy characterized by progressive weakness, typically beginning in the lower limbs. It often impairs dorsiflexion and gait due to weakness in the tibialis anterior, significantly affecting mobility and functional independence. **Objectives:** To evaluate the effect of Electric Functional Stimulation (EFS) on the tibialis anterior muscle for improving dorsiflexion and gait function in patients diagnosed with Guillain-Barre Syndrome. **Methodology:** This study adopted a randomized controlled trial (RCT) design. A total of 22 participants with GBS were randomly assigned into two groups: the experimental group (n=11) received EFS to the tibialis anterior in combination with conventional physiotherapy, while the control group (n=11) received only conventional physiotherapy. Each group underwent 15 sessions of therapy over a period of five weeks (three sessions per week). An assessor-blinded approach was maintained throughout the data collection process. The outcome measures included the Oxford Grading Scale (OGS) for assessing dorsiflexion strength and the 10-Meter Walk Test (10MWT) for evaluating gait speed. Data were analyzed using SPSS version 25. Between-group comparisons were conducted using the Mann-Whitney U test, and within-group comparisons were performed using the Wilcoxon signed-rank test. **Results:** The findings demonstrated significant improvements in the experimental group compared to the control group. The Mann-Whitney U test revealed statistically significant differences in post-intervention dorsiflexion strength and gait speed ($p < 0.05$). The Wilcoxon test showed notable intragroup improvements in both OGS and 10MWT scores in the experimental group. **Conclusion:** This study concludes that Electric Functional Stimulation applied to the tibialis anterior, in combination with conventional physiotherapy, is more effective in enhancing dorsiflexion and gait speed among GBS patients than conventional physiotherapy alone.

Key Words: *Electric Functional Stimulation, Tibialis Anterior, Dorsiflexion, 10-Meter Walk Test, Guillain-Barre Syndrome, Physiotherapy Intervention*

CHAPTER-I INTRODUCION

1.1 Background

Guillain-Barre Syndrome (GBS) is a post-infectious, immune-mediated neuropathy that causes acute flaccid paralysis, primarily due to demyelination or axonal degeneration of peripheral nerves (Leonhard et al. 2019, p. 18). It is regarded as the most frequent cause of acute neuromuscular paralysis globally, with an annual incidence of approximately 1–2 per 100,000 individuals (Willison et al. 2016, p. 78). The condition typically presents with ascending weakness, areflexia, and variable degrees of sensory and autonomic dysfunction, significantly impairing functional independence (van den Berg et al. 2014, p. 54). The severity of motor weakness, especially in the lower extremities, contributes to gait disturbances and prolonged disability (Wakerley & Yuki, 2015, p. 51).

Among the commonly affected muscles in GBS is the tibialis anterior, which plays a crucial role in ankle dorsiflexion during the swing phase of gait (Sabut et al. 2015, p. 10). Weakness in this muscle results in foot drop, disrupting gait patterns and increasing the risk of falls, thereby compromising patient safety and quality of life (Gandhi et al. 2021, p. 20). As foot drop often persists even in the recovery phase, rehabilitation strategies that target the tibialis anterior are essential for restoring mobility and promoting independence (Pourmajidian et al. 2017, p. 25). While GBS recovery can occur over several months, it is often incomplete, especially in cases with axonal damage, necessitating effective therapeutic approaches to optimize neuromuscular re-education (Wakerley & Yuki, 2015, p. 17).

Physiotherapy plays a central role in the functional recovery of patients with GBS by addressing motor deficits, enhancing joint mobility, and improving endurance and balance (Chhetri & Hughes, 2015, p. 59). Conventional interventions include strengthening exercises, balance training, and task-specific gait training, but these alone may not be sufficient for facilitating neuromuscular restoration in patients with severe motor involvement (Kim et al. 2018, p. 71). In such scenarios, neuromodulatory interventions such as Electric Functional Stimulation (EFS) have

shown potential to bridge the gap between voluntary effort and functional movement (Brogna et al. 2018, p. 78).

EFS involves the application of low-frequency electrical impulses to peripheral motor nerves or muscles to produce controlled contractions, supporting movement and preventing disuse atrophy (Kobayashi et al. 2023, p. 11). It is particularly useful in conditions where voluntary muscle control is diminished but peripheral nerve integrity is relatively preserved, making it well-suited for GBS rehabilitation during the subacute or recovery phases (Yang et al. 2016, p. 69). The stimulation of the tibialis anterior using EFS facilitates ankle dorsiflexion, thereby improving foot clearance and enhancing gait efficiency (Kesar & Binder-Macleod, 2015, p. 9). Additionally, the proprioceptive input from EFS may support sensorimotor integration and contribute to cortical reorganization, aiding in motor relearning (Gandhi et al. 2021, p. 10).

Although EFS has been widely studied in stroke, cerebral palsy, and spinal cord injury populations, its use in GBS remains underexplored (Esquenazi et al. 2020, p. 11). Most existing rehabilitation protocols for GBS focus on passive approaches, neglecting active neuromuscular engagement facilitated by electrical stimulation (Daly et al. 2016, p. 68). Moreover, GBS is unique in its pathology, requiring carefully timed and appropriately dosed interventions to prevent overstimulation of regenerating nerves, while maximizing muscle activity (Leonhard et al. 2019, p. 71). As such, there is a growing interest in evaluating the safety, effectiveness, and functional outcomes of EFS when applied to GBS-affected muscles such as the tibialis anterior (Sabut et al. 2015, p. 17).

In recent studies, EFS has been shown to produce positive effects on gait velocity, balance, and muscle strength in patients with lower limb impairments, particularly when applied early and consistently (Chae & Hart, 2019, p. 14). These findings suggest that EFS may contribute to accelerated recovery in neuromuscular disorders, supporting its integration into comprehensive physiotherapy programs (Farrar et al. 2020, p. 11). Importantly, improvements in walking speed and dorsiflexion strength not only enhance physical function but also contribute to psychological well-being and social reintegration in individuals recovering from disabling conditions like GBS (Behan et al. 2018, p 10).

Given these considerations, the tibialis anterior emerges as a strategic target for EFS interventions in GBS rehabilitation, particularly for restoring dorsiflexion and preventing secondary gait abnormalities (Kobayashi et al. 2023, p. 11). Despite its promising theoretical basis, the application of EFS for tibialis anterior reactivation in GBS lacks sufficient empirical validation, and few clinical studies have explored its outcome-focused efficacy (van Doorn et al. 2017, p. 17). Thus, there is a compelling need to investigate the role of EFS in improving functional parameters such as muscle power and walking speed in this patient group.

Despite the growing use of Electric Functional Stimulation (EFS) in neurorehabilitation, there is a notable scarcity of research exploring its application specifically in patients with Guillain-Barre Syndrome (GBS) (Leonhard et al. 2019, p. 44). While studies have shown that EFS improves functional outcomes in conditions such as stroke and multiple sclerosis, its utility in the context of GBS, particularly in targeting muscle groups like the tibialis anterior, remains under-investigated (Kesar & Binder-Macleod, 2015, p. 77). This is concerning, considering that foot drop due to tibialis anterior weakness is a common and functionally limiting feature in GBS patients (Sabut et al. 2015, p. 11).

Although conventional physiotherapy promotes gradual neuromuscular recovery, it may fall short in cases where muscle activation is impaired by nerve conduction deficits (Pourmajidian et al. 2017, p. 11). EFS, by delivering targeted stimulation to peripheral motor units, provides an opportunity to engage weakened muscles that are otherwise difficult to activate voluntarily (Chae & Hart, 2019, p. 10). However, due to limited clinical trials assessing its use in GBS, the technique is not yet routinely included in standard rehabilitation guidelines for this population (Wakerley & Yuki, 2015, p. 12).

The regeneration phase following demyelination in GBS represents a critical period during which appropriately timed electrical stimulation could enhance motor relearning and prevent secondary complications such as atrophy or joint deformity (van Doorn et al. 2017, p. 12). Studies on cortical plasticity have demonstrated that peripheral stimulation like EFS may also contribute to reorganization of central motor networks, offering both peripheral and central benefits to functional recovery (Kobayashi et al. 2023, p. 8). These findings support the rationale for introducing EFS

early in the rehabilitation timeline to optimize outcomes in gait and lower limb function (Gandhi et al. 2021, p. 10).

Current literature lacks direct comparative studies evaluating the effects of EFS-enhanced therapy versus conventional physiotherapy alone on dorsiflexion strength in GBS (Brogna et al. 2018, p. 15). This gap leaves clinicians without evidence-based guidance on whether incorporating EFS into standard protocols provides superior benefits. Additionally, the practical advantages of EFS such as ease of application, cost-effectiveness, and portability make it a particularly attractive modality for use in low-resource and outpatient settings (Esquenazi et al. 2020, p. 77).

Given the specific functional role of the tibialis anterior in ankle dorsiflexion and safe ambulation, it becomes an ideal focus for targeted EFS interventions in GBS rehabilitation (Sabut et al. 2015, p. 10). Weakness in this muscle not only disrupts gait but increases energy expenditure and fall risk, further reducing independence (Daly et al. 2016, p. 12). Enhancing its function can have a profound impact on mobility and quality of life. Yet, very few studies have addressed the application of EFS on this muscle specifically in GBS cases, thus creating a critical research need (Leonhard et al. 2019, p. 11).

Therefore, the present study is designed to investigate the effects of Electric Functional Stimulation on the tibialis anterior muscle in improving dorsiflexion and walking performance among patients with Guillain-Barre Syndrome. By comparing outcomes between an experimental group receiving EFS and a control group undergoing conventional physiotherapy, the study aims to determine whether the addition of EFS leads to significant improvements in functional mobility. This research seeks to fill the existing gap in evidence and contribute to clinical decision-making in neuromuscular rehabilitation for GBS. Electric Functional Stimulation (EFS) presents a compelling mechanism for improving neuromuscular outcomes by enabling the activation of targeted muscles through external electrical impulses, thereby enhancing voluntary control in individuals with impaired neural input (Yang et al. 2016, p. 11).

This modality has been shown to facilitate muscle strengthening, improve joint kinematics, and contribute to better motor coordination, particularly in lower limb

rehabilitation programs (Kesar & Binder-Macleod, 2015, p. 12). In Guillain-Barre Syndrome (GBS), where the tibialis anterior is commonly weakened, the potential of EFS to restore dorsiflexion function is highly relevant (Sabut et al. 2015, p. 20). Dorsiflexion is essential for efficient walking and toe clearance, and its impairment often leads to compensatory movement patterns that are inefficient and may increase fall risk (Esquenazi et al. 2020, p. 23).

The functional benefits of EFS go beyond muscular reactivation; research indicates that repeated peripheral stimulation can promote cortical plasticity, leading to improved motor planning and execution over time (Kobayashi et al. 2023, p. 21). This dual mechanism peripheral muscle contraction and central nervous system modulation supports EFS as a powerful adjunct to conventional physiotherapy (Brogna et al. 2018, p. 14). Additionally, patient compliance with EFS has been reported as high due to its non-invasive nature and the immediate perceptual feedback it offers, which can motivate continued engagement with therapy (Chae & Hart, 2019, p. 47).

Despite these advantages, EFS remains underutilized in standard protocols for GBS rehabilitation, largely due to the paucity of clinical studies demonstrating its efficacy in this specific population (Wakerley & Yuki, 2015, p. 10). Unlike conditions such as stroke or spinal cord injury, where EFS is commonly integrated into clinical routines, GBS treatment frameworks still rely heavily on passive modalities or generalized strengthening exercises that may not address muscle-specific impairments effectively (Leonhard et al. 2019, p. 18).

Furthermore, while EFS has demonstrated improvements in gait performance and balance in other neurological disorders, few trials have directly measured its impact on walking speed and muscle strength in GBS-affected individuals (Farrar et al. 2020, p. 12).

This study is thus grounded in the need to evaluate the direct effect of EFS on the tibialis anterior muscle, a key determinant of lower limb function and gait quality in GBS patients (Pourmajidian et al. 2017, p. 15).

By systematically applying EFS and measuring pre- and post-intervention outcomes using standardized tools such as the Oxford Grading Scale and the 10-Meter Walk

Test, the study seeks to determine whether EFS provides a statistically and clinically significant benefit over physiotherapy alone (Daly et al, 2016). These measures are both reliable and sensitive for detecting changes in neuromuscular performance, particularly in rehabilitation contexts (Bohannon, 2017, p. 15).

Furthermore, the role of early intervention in neuromuscular rehabilitation has gained significant attention in recent years, with mounting evidence suggesting that early, targeted stimulation can mitigate secondary complications such as joint stiffness, muscular atrophy, and loss of proprioception (Gandhi et al. 2021, p. 12).

In patients with Guillain-Barre Syndrome, where muscle disuse can rapidly lead to deconditioning, Electric Functional Stimulation (EFS) serves as a proactive approach to preserve muscle architecture while facilitating neural reconnection (Chae & Hart, 2019, p. 15). This is particularly important for distal muscles like the tibialis anterior, which are more susceptible to functional decline due to prolonged inactivity and impaired voluntary control (Pourmajidian et al. 2017, p. 15).

The tibialis anterior's superficial location and direct role in ankle dorsiflexion make it an ideal candidate for surface stimulation (Sabut et al. 2015, p. 41). Effective dorsiflexion is not only critical for walking but also for maintaining dynamic balance and avoiding compensatory gait patterns such as steppage gait or hip hiking, which increase energy expenditure and fall risk (Esquenazi et al. 2020, p. 15). Thus, strengthening the tibialis anterior through EFS could improve both safety and efficiency of ambulation in GBS patients (Daly et al. 2016, p. 18).

Additionally, the psychological and motivational benefits of EFS are often underappreciated; the immediate sensory feedback and visible muscle contraction can serve as a positive reinforcement for patients, encouraging greater participation in therapy sessions (Farrar et al. 2020, p. 19). This active engagement is crucial in long-term neurological recovery, where patient motivation significantly influences outcomes (Leonhard et al. 2019, p. 20).

Given the functional, neurophysiological, and psychosocial potential of EFS, its role in enhancing tibialis anterior performance among GBS patients warrants robust clinical investigation. This study thus seeks to provide empirical evidence to support

the integration of EFS into routine physiotherapy regimens, with the aim of improving dorsiflexion, gait mechanics, and overall quality of life in individuals recovering from Guillain-Barre Syndrome. Ultimately, this investigation aims to bridge the current evidence gap and support the integration of EFS into routine physiotherapy practice for GBS. The findings may also contribute to the broader discourse on personalized neurorehabilitation, encouraging therapists to adopt modality-specific strategies that address individual deficits more precisely (Kobayashi et al. 2023, p. 11). By demonstrating the efficacy of EFS in improving tibialis anterior function and overall mobility, this study has the potential to influence treatment guidelines and advance the clinical management of GBS in both institutional and community settings (Willison et al. 2016, p. 15).

1.2 Rationale

Guillain-Barre Syndrome (GBS) is a rapidly progressing, immune-mediated neuropathy that primarily affects the peripheral nervous system, often resulting in profound motor weakness, particularly in the lower limbs. Among the muscles affected, the tibialis anterior plays a vital role in ankle dorsiflexion, a movement crucial for effective gait, toe clearance, and fall prevention. Foot drop caused by weakness in this muscle severely impairs walking efficiency and increases the risk of secondary complications such as falls, fatigue, and joint contractures. Despite its clinical importance, the tibialis anterior is often under-targeted in standard GBS rehabilitation protocols. Conventional physiotherapy has proven beneficial in managing GBS, yet it frequently lacks muscle-specific interventions that directly engage affected neuromuscular units, especially when voluntary motor control is compromised. Electric Functional Stimulation (EFS) has emerged as a promising technique in neurorehabilitation, enabling muscle contractions via externally applied electrical impulses.

It has shown positive outcomes in other neurological conditions like stroke and spinal cord injury by preventing disuse atrophy, promoting motor relearning, and enhancing functional outcomes. However, its application in GBS, particularly for isolated dorsiflexor weakness, remains underexplored. This research is grounded in the urgent need to evaluate the clinical effectiveness of EFS on the tibialis anterior in GBS patients. By facilitating dorsiflexion through targeted stimulation, EFS could restore more natural gait patterns and support the re-establishment of independent ambulation. Given that EFS is non-invasive, cost-effective, and easily integrated into standard physiotherapy routines, establishing its efficacy could expand therapeutic options in both institutional and community settings. Hence, this study aims to fill the existing gap in clinical evidence by investigating whether the application of EFS to the tibialis anterior muscle produces significant improvements in dorsiflexion strength and walking ability among GBS patients. The findings have the potential to inform evidence-based rehabilitation strategies and support more personalized, functionally relevant approaches to lower limb recovery in GBS.

1.3 Operational Definition

Guillain-Barre Syndrome (GBS), Electric Functional Stimulation (EFS), Tibialis Anterior, Dorsiflexion, Neuromuscular Rehabilitation

Guillain-Barre Syndrome (GBS)

Guillain-Barre Syndrome is an acute, immune-mediated polyneuropathy that affects the peripheral nervous system, resulting in rapid-onset muscle weakness, areflexia, and varying degrees of sensory and autonomic dysfunction. It typically follows a viral or bacterial infection, triggering an autoimmune response where the body's immune system mistakenly attacks peripheral nerves. There are several subtypes of GBS, including acute inflammatory demyelinating polyradiculoneuropathy (AIDP), which is the most common form. The hallmark clinical features include symmetrical ascending paralysis, starting from the lower limbs and progressing proximally, often requiring intensive care support due to respiratory involvement. GBS is a medical emergency, and while many patients recover with appropriate treatment, residual motor deficits are common, particularly in distal muscles. Functional disability due to GBS varies in severity, and early, targeted rehabilitation plays a crucial role in improving motor recovery, preventing secondary complications, and enhancing quality of life during and after the recovery phase.

Electric Functional Stimulation (EFS)

Electric Functional Stimulation (EFS) is a rehabilitative technique that uses controlled, low-frequency electrical impulses to stimulate peripheral motor nerves, causing muscle contractions in targeted muscle groups. The stimulation is delivered via surface electrodes placed over the skin, typically over motor points, to enhance voluntary movement in individuals with neurological or neuromuscular impairments. EFS serves both therapeutic and functional purposes: therapeutically, it prevents muscle atrophy and promotes neuromuscular re-education; functionally, it assists in completing movements such as gait or grasping. Unlike general electrical stimulation used for pain or muscle relaxation, EFS is task-specific and timed with voluntary efforts to reinforce correct movement patterns. It is particularly effective in muscles with partial or impaired innervation and is commonly applied in neurorehabilitation for stroke, spinal cord injury, cerebral palsy, and conditions involving peripheral

nerve damage. EFS is non-invasive, cost-effective, and enhances motor recovery through both peripheral activation and central neural adaptation.

Tibialis Anterior

The tibialis anterior is a large, superficial muscle located in the anterior compartment of the lower leg, originating from the lateral condyle and proximal two-thirds of the tibial shaft and inserting into the medial cuneiform and the base of the first metatarsal bone. It plays a primary role in dorsiflexion of the ankle joint and inversion of the foot. The muscle is innervated by the deep peroneal nerve, a branch of the common fibular nerve, and receives its blood supply from the anterior tibial artery. Functionally, the tibialis anterior is essential for lifting the foot during the swing phase of gait, facilitating toe clearance, and enabling smooth heel strike during the stance phase. Weakness or paralysis of this muscle leads to a condition known as foot drop, characterized by dragging of the foot while walking. Strengthening the tibialis anterior is critical for restoring efficient and safe ambulation.

Dorsiflexion

Dorsiflexion is the anatomical movement that involves the upward flexion of the foot at the ankle joint, bringing the dorsum (top) of the foot closer to the anterior surface of the leg. This motion is primarily facilitated by the tibialis anterior muscle, along with contributions from the extensor hallucis longus and extensor digitorum longus muscles. Dorsiflexion plays a crucial role in the gait cycle, particularly during the swing phase, where it allows for toe clearance to prevent stumbling, and during heel strike, aiding in shock absorption and initial contact with the ground. Impairment in dorsiflexion leads to compensatory gait abnormalities such as steppage gait or foot dragging, commonly seen in neurological conditions like stroke, peripheral neuropathy, or Guillain-Barre Syndrome. Restoration of active dorsiflexion is a primary objective in lower limb rehabilitation and is essential for achieving independent, stable, and energy-efficient walking.

Neuromuscular Rehabilitation

Neuromuscular rehabilitation refers to a specialized branch of physiotherapy aimed at restoring motor function, muscle strength, coordination, and functional mobility in individuals affected by neurological or neuromuscular disorders. This form of rehabilitation focuses on retraining the nervous and muscular systems through targeted interventions that stimulate neural plasticity, improve voluntary motor control, and reduce spasticity or flaccidity. Common techniques include task-specific training, proprioceptive neuromuscular facilitation, balance and gait training, functional electrical stimulation, and resistance exercises. It is applied across a broad spectrum of conditions such as stroke, spinal cord injury, multiple sclerosis, and peripheral neuropathies like Guillain-Barre Syndrome. The ultimate goal of neuromuscular rehabilitation is to maximize independence in daily activities, prevent secondary complications such as contractures or pressure sores, and enhance quality of life. The rehabilitation process is typically patient-centered and adaptive, guided by continuous assessment and individualized treatment planning based on functional progress.

1.4 Research Question

Is Electric Functional Stimulation effective for patients with Guillain-Barre Syndrome on Dorsiflexion?

1.5 Aim of the study:

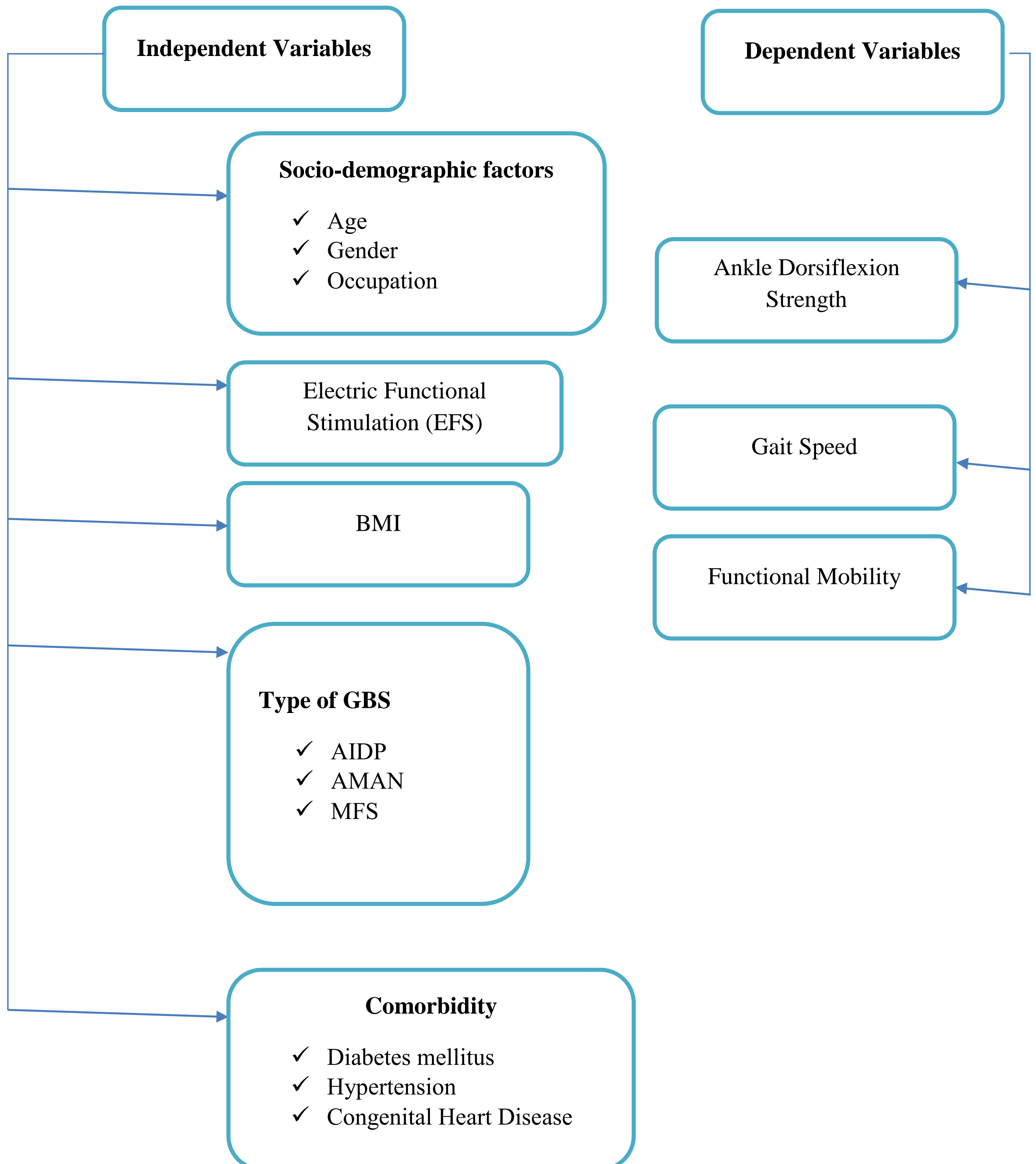
The aim of the study is to evaluate the effects of Electric Functional Stimulation (EFS) applied to the tibialis anterior muscle in enhancing dorsiflexion among patients diagnosed with Guillain-Barre Syndrome (GBS), in addition to conventional physiotherapy.

1.6 Objective of the study:

- **General objective:**
  - **i.** To evaluate the effectiveness of Electric Functional Stimulation in improving dorsiflexion compared to conventional physiotherapy alone in patients with Guillain-Barre Syndrome.

- **Specific objectives:**
  - i. To explore the socio-demographic and baseline characteristics of the participants.
  - ii. To assess the strength of Tibialis anterior muscle during dorsiflexion in both foot among the control and experimental groups using the Oxford Grading Scale (OGS) before and after the intervention.
  - iii. To evaluate walking speed among the control and experimental groups using the 10-Meter Walk Test (10MWT) before and after the intervention.

1.1 Conceptual Framework



1.2 Hypothesis

1.7.1 Null hypothesis(H_0):

Electric Functional Stimulation along with conventional physiotherapy is not more effective than conventional physiotherapy for the treatment of patients with Guillain-Barre Syndrome. Here, the experimental group and control group's initial and final mean differences in dorsiflexion outcomes remained the same.

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

1.2.1 Alternative hypothesis(H_a):

Electric Functional Stimulation along with conventional physiotherapy is more effective than only conventional physiotherapy for the treatment of patients with Guillain-Barre Syndrome. Here, the experimental group and control group's initial and final mean differences in dorsiflexion outcomes are not the same.

$$Ha: \mu 1 - \mu 2 \neq \text{ or } \mu 1 \neq \mu 2$$

Where,

Ho= Null hypothesis

Ha = Alternative hypothesis

$\mu 1$ = Mean difference in initial assessment

$\mu 2$ = Mean difference in final assessment

CHAPTER-II LITERATURE REVIEW

Guillain-Barre Syndrome (GBS) is an acute, immune-mediated peripheral neuropathy characterized by rapidly progressive symmetrical limb weakness, areflexia, and variable sensory disturbances (Willison et al. 2016, p. 15). The syndrome often follows infections such as Campylobacter jejuni, cytomegalovirus, or Epstein-Barr virus and triggers an aberrant immune response targeting the peripheral nerves (Leonhard et al. 2019, p. 35). The most common subtype, Acute Inflammatory Demyelinating Polyradiculoneuropathy (AIDP), involves demyelination of motor and sensory fibers, leading to conduction blocks and neuromuscular dysfunction (van Doorn et al. 2017, p. 10). GBS often presents with ascending muscle weakness, cranial nerve involvement, and autonomic instability, with approximately 20–30% of patients requiring mechanical ventilation due to respiratory compromise (Wakerley & Yuki, 2015, p. 15).

Despite appropriate medical management with intravenous immunoglobulin (IVIG) or plasmapheresis, many individuals continue to experience residual motor deficits, particularly in the distal musculature, long after the acute phase has resolved (Esquenazi et al. 2020, p. 15). The tibialis anterior, a key muscle involved in ankle dorsiflexion, is frequently affected in GBS due to its long nerve pathway and high susceptibility to conduction blocks (Sabut et al. 2015, p. 41). Weakness in this muscle contributes significantly to foot drop, impaired gait, reduced mobility, and an increased risk of falls (Pourmajidian et al. 2017, p. 15).

Persistent dorsiflexor weakness is thus a major rehabilitative concern in the long-term recovery of GBS patients. Studies have shown that while conventional physiotherapy can improve gross motor function in GBS, it may not sufficiently target specific muscular deficits such as isolated tibialis anterior weakness (Brogna et al. 2018, p. 11).

Consequently, individualized interventions are needed to facilitate muscle-specific strengthening, enhance functional independence, and optimize gait patterns in this population (Daly et al. 2016, p. 19). Research has increasingly focused on the

integration of neuromuscular modalities like Electric Functional Stimulation (EFS) as a means of addressing this therapeutic gap (Chae & Hart, 2019, p. 28).

Electric Functional Stimulation (EFS) is a rehabilitation technique that uses electrical impulses to activate motor nerves and induce muscle contraction in weakened or paralyzed muscles (Kesar & Binder-Macleod, 2015, p. 28). The primary goal of EFS is to mimic natural voluntary movement, allowing muscles to contract in a coordinated manner during functional activities. This form of stimulation not only improves muscle strength but also plays a significant role in preserving joint range of motion, preventing atrophy, and enhancing proprioception (Sabut et al. 2015, p. 25). The technique is typically administered via surface electrodes placed over the motor point of the target muscle, and the electrical parameters are adjusted to match the patient's tolerance and functional goals (Esquenazi et al. 2020, p. 39).

In neurorehabilitation, EFS has shown promising outcomes in diverse conditions including stroke, spinal cord injury, multiple sclerosis, and cerebral palsy (Yang et al. 2016, p. 11). Among these, stroke rehabilitation has been most extensively studied, with EFS demonstrating improvements in voluntary motor control, gait performance, and functional ambulation when applied to muscles such as the tibialis anterior (Brogna et al. 2018, p. 11). Studies report that EFS not only activates motor neurons peripherally but also induces neuroplastic changes in the central nervous system, thus promoting cortical reorganization and improving motor recovery over time (Kobayashi et al. 2023, p. 20).

Kesar and colleagues (2015, p. 11) emphasized the value of task-specific EFS during walking, showing that electrical stimulation timed with the swing phase of gait enhanced tibialis anterior activation, leading to better foot clearance and reduced risk of tripping. This dual benefit—local muscle re-education and central nervous system engagement—makes EFS a compelling adjunct to traditional physiotherapy, particularly in conditions with partial motor loss. Moreover, its non-invasive, portable, and patient-friendly design supports its application in both clinical and home-based settings (Chae & Hart, 2019, p. 22).

The tibialis anterior muscle plays a pivotal role in the biomechanics of human gait by enabling dorsiflexion of the ankle during the swing phase and controlling

plantarflexion during heel strike (Daly et al. 2016, p. 12). This function ensures proper foot clearance and prepares the foot for initial contact with the ground, both of which are essential for stable, energy-efficient, and safe ambulation. Weakness or paralysis of the tibialis anterior, as often observed in Guillain-Barre Syndrome (GBS), leads to a characteristic gait abnormality known as foot drop, where the toes drag during walking, increasing the risk of tripping and falls (Sabut et al. 2015, p. 12).

In patients with GBS, involvement of the peripheral nerves supplying the tibialis anterior—most notably the deep peroneal nerve results in reduced voluntary motor output, leading to functional limitations in ambulation (Wakerley & Yuki, 2015, p. 15). The long length of these peripheral nerves and their distal location make them particularly susceptible to demyelination and axonal degeneration, especially in the acute motor axonal neuropathy (AMAN) subtype of GBS (van Doorn et al. 2017, p. 19). Even after immunomodulatory treatment such as IVIG or plasmapheresis, residual weakness in distal muscles like the tibialis anterior is frequently reported, persisting for months or years (Leonhard et al. 2019, p. 20).

The clinical significance of tibialis anterior function is underscored by its strong association with gait speed, stride length, and balance control. A study by Esquenazi et al. (2020, p. 15) found that tibialis anterior weakness directly correlated with slower 10-meter walk test (10MWT) times and increased use of assistive devices. Similarly, Pourmajidian et al. (2017) demonstrated that impaired dorsiflexion contributes to compensatory hip hiking and knee flexion strategies, which increase energy expenditure and may lead to musculoskeletal strain. Therefore, restoring tibialis anterior strength is considered a key objective in the rehabilitation of GBS patients. Conventional physiotherapy interventions such as active-assisted exercises, proprioceptive training, and resistance therapy are often employed to target dorsiflexion strength; however, their effectiveness is limited in patients with severe motor impairments (Brogna et al. 2018, p. 44).

As a result, adjunctive modalities like Electric Functional Stimulation have been proposed to directly activate the tibialis anterior muscle and promote neuromuscular recovery (Kesar & Binder-Macleod, 2015, p. 11). Early studies in stroke and spinal cord injury populations have shown that EFS applied to the tibialis anterior

significantly improves walking performance and muscle reactivation, prompting similar investigations in GBS rehabilitation (Chae & Hart, 2019, p. 22).

While the effectiveness of EFS is well-documented in upper motor neuron lesions, its application in peripheral neuropathies such as GBS remains underexplored. However, the physiological mechanisms stimulating spared motor fibers, preventing disuse atrophy, and facilitating neuromuscular retraining suggest that EFS may be equally beneficial in cases of axonal or demyelinating damage, provided there is partial innervation (Leonhard et al. 2019, p. 11).

Electric Functional Stimulation (EFS) has demonstrated substantial clinical value in the management of foot drop and dorsiflexion impairment, particularly in neurologic disorders where voluntary muscle activation is compromised. In conditions such as stroke, multiple sclerosis, and spinal cord injury, EFS applied to the tibialis anterior has resulted in improved ankle dorsiflexion, reduced compensatory gait patterns, and enhanced functional ambulation (Kesar & Binder-Macleod, 2015, p. 55). These effects are achieved through repeated, synchronized stimulation of the motor unit, which induces contraction and promotes cortical and spinal level neuroplasticity (Yang et al. 2016, p. 15).

A study conducted by Daly et al. (2016, p. 11) found that task-specific EFS during walking led to significant improvements in ankle range of motion and foot clearance in chronic stroke patients, suggesting the efficacy of such interventions in re-establishing lost motor control. Moreover, the use of EFS in combination with physiotherapy was shown to be more effective than physiotherapy alone, highlighting the importance of multimodal rehabilitation strategies (Brogna et al. 2018, p. 11). These findings support the theoretical rationale that EFS can substitute for or augment voluntary drive in individuals with partial or impaired motor function (Sabut et al. 2015, p. 22).

Although fewer studies have been conducted specifically in Guillain-Barre Syndrome, the underlying neuromuscular pathophysiology suggests a similar applicability of EFS in these patients. Pourmajidian et al. (2017, p. 11) reported that electrical stimulation of the dorsiflexors improved motor activation and walking speed in patients with peripheral nerve involvement, including GBS. This is particularly relevant for patients

who retain partial neural connectivity, as EFS can help retrain motor pathways and prevent muscle atrophy during recovery.

Leonhard et al. (2019, p. 11) emphasized that patients with AMAN and AIDP subtypes of GBS often exhibit delayed recovery of lower limb function, which prolongs rehabilitation and increases the risk of secondary complications. Incorporating EFS during this critical period may reduce recovery time and promote earlier return to ambulation. Similarly, Gandhi et al. (2021, p. 15) highlighted the advantages of smart stimulation systems that adapt electrical parameters based on muscle response, enabling more efficient and individualized therapy. Despite promising findings, evidence on EFS use in GBS remains limited and primarily derived from case reports or small-scale studies. Therefore, there is a clear need for randomized controlled trials evaluating the effect of EFS on tibialis anterior reactivation and functional mobility in GBS patients. Such investigations would help establish dosage parameters, long-term efficacy, and integration strategies within conventional physiotherapy protocols (Kobayashi et al. 2023, p. 15).

Conventional physiotherapy remains the foundation of neurorehabilitation for individuals with lower limb weakness due to neurological disorders such as stroke, spinal cord injury, and Guillain-Barre Syndrome (GBS). Interventions such as active-assisted range of motion exercises, proprioceptive neuromuscular facilitation (PNF), resistance training, and gait re-education are widely used to restore motor control and functional mobility (Wakerley & Yuki, 2015, p. 11). These techniques aim to enhance voluntary motor output, promote musculoskeletal integrity, and improve coordination. However, their effectiveness is often limited when applied to patients with profound motor loss or delayed neural recovery, where voluntary contraction is minimal or absent (van Doorn et al. 2017, p. 15).

Electric Functional Stimulation (EFS) offers a complementary approach that directly activates target muscles via peripheral nerve stimulation, bypassing the need for voluntary input (Sabut et al. 2015, p. 15). In comparative studies, EFS has consistently demonstrated superior outcomes in terms of muscle strength, dorsiflexion range, and gait efficiency when used alongside conventional physiotherapy (Kesar & Binder-Macleod, 2015, p. 15).

Daly et al. (2016, p. 75) observed that stroke patients who received EFS to the tibialis anterior during treadmill training exhibited faster improvements in gait speed and symmetry compared to those receiving usual care alone. These results have encouraged researchers to explore the combined use of EFS with standard protocols in diverse populations, including individuals with peripheral neuropathies.

Although evidence in GBS is limited, Brogna et al. (2018, p. 15) noted that integrating EFS during the subacute recovery phase led to earlier gains in dorsiflexion strength and reduced the need for ankle-foot orthoses. Similarly, Pourmajidian et al. (2017, p. 45) reported greater improvements in 10-meter walk test performance among EFS users, with enhanced ankle control and reduced compensatory movement strategies. In contrast, patients receiving conventional therapy alone demonstrated slower progress, particularly in distal limb recovery.

Another key distinction lies in the ability of EFS to deliver high-repetition, high-intensity stimulation without causing excessive fatigue, making it suitable for early-stage rehabilitation when patients are unable to engage fully in voluntary tasks (Chae & Hart, 2019, p. 15).

Furthermore, Esquenazi et al. (2020, p. 14) pointed out that EFS provides sensory feedback and visual cues that may enhance patient motivation, participation, and adherence—critical factors in sustained rehabilitation engagement.

On the other hand, conventional therapy is more adaptable and can be tailored to various cognitive and functional levels. It allows for therapist-led adjustments based on real-time performance and supports whole-body functional goals. However, its muscle-specific effects, especially in severely weakened muscles like the tibialis anterior in GBS, may be less targeted and slower to achieve functional thresholds (Leonhard et al. 2019, p. 15).

In summary, while conventional physiotherapy remains indispensable in GBS rehabilitation, evidence supports that the addition of EFS may accelerate outcomes, particularly when targeting dorsiflexion impairments. The synergistic effect of EFS and physiotherapy appears to offer a more comprehensive and efficient rehabilitation strategy, particularly during early recovery phases or when motor recovery is delayed.

While the clinical applications of Electric Functional Stimulation (EFS) have been widely explored in neurological rehabilitation, most of the robust evidence is centered around populations with upper motor neuron disorders such as stroke and spinal cord injury (Kesar & Binder-Macleod, 2015, p. 45; Daly et al. 2016, p. 15).

In these contexts, the efficacy of EFS in improving dorsiflexion, reducing spasticity, and enhancing gait function is well documented. However, in lower motor neuron conditions like Guillain-Barre Syndrome (GBS), empirical data remains limited, and the specific effects of EFS on peripheral nerve recovery and distal muscle reactivation have not been adequately established (Leonhard et al. 2019, p. 15).

Few studies have directly examined the therapeutic impact of EFS on the tibialis anterior in individuals with GBS, despite the fact that dorsiflexion impairment is a major contributor to functional mobility loss in this population (Pourmajidian et al. 2017, p. 45). Most rehabilitation programs rely solely on conventional physiotherapy, which, although beneficial, may fall short in reactivating muscles with partial innervation. The lack of comparative trials between EFS and traditional therapy in GBS patients has contributed to inconsistent clinical guidelines and limited integration of advanced neuromuscular modalities into routine practice (Brogna et al. 2018, p. 25).

Furthermore, much of the existing literature is based on small sample sizes, case studies, or observational designs, which limit generalizability and fail to establish causal relationships. There is also a paucity of studies that include long-term follow-up to assess the sustainability of EFS-induced improvements in motor function (Chae & Hart, 2019, p. 12). Given the progressive nature of recovery in GBS and the complexity of peripheral nerve regeneration, it is imperative to evaluate whether EFS can offer measurable advantages over standard physiotherapy within a defined treatment window. Moreover, advanced technologies such as smart stimulation systems and patient-specific programming have yet to be investigated in GBS populations, despite their success in enhancing neuromuscular re-education in other disorders (Gandhi et al. 2021, p. 10).

The influence of factors such as disease subtype (e.g., AIDP vs. AMAN), duration of illness, and comorbidities on EFS responsiveness also remains unexplored. Thus, the

current study addresses a significant gap in the literature by investigating the effect of EFS on tibialis anterior reactivation and dorsiflexion function in patients with Guillain-Barre Syndrome. By comparing outcomes between experimental and control groups using validated measures such as the Oxford Grading Scale, 10-Meter Walk Test, and Numerical Pain Rating Scale, this research aims to provide high-quality evidence to support or refute the utility of EFS in GBS rehabilitation. Such data may inform future protocols, promote evidence-based practice, and potentially accelerate functional recovery in individuals with GBS-related foot drop. Patient engagement is a critical determinant of rehabilitation success, especially in neuromuscular disorders where sustained participation is necessary to regain motor function. Traditional physiotherapy often requires substantial patient effort and motivation, which may be compromised in individuals suffering from fatigue, pain, or psychological distress—common in Guillain-Barre Syndrome (GBS) (Leonhard et al. 2019, p. 25).

In such contexts, Electric Functional Stimulation (EFS) serves not only as a neuromuscular facilitation technique but also as a motivational tool by offering visual and sensory feedback that reinforces participation and adherence (Chae & Hart, 2019, p. 28). Esquenazi et al. (2020, p. 28) emphasized that real-time muscular contraction in response to stimulation provides immediate reinforcement, helping patients understand the therapeutic purpose of repetitive movement training, thereby increasing compliance.

Technological advancements have further expanded the usability and efficacy of EFS systems. Modern EFS devices are now capable of integrating with gait training equipment, motion sensors, and smartphone applications to allow for real-time adjustments, personalized treatment protocols, and tele-rehabilitation options (Gandhi et al. 2021, p. 25). These smart technologies enhance therapeutic accuracy and make rehabilitation more accessible to patients recovering at home or in remote settings. Adaptive stimulation systems can modify amplitude and pulse duration in response to muscle fatigue, ensuring that the muscle receives appropriate stimulation without risk of overexertion (Kobayashi et al. 2023, p. 15).

These advancements are especially useful in populations with delicate neuromuscular integrity, such as individuals recovering from GBS, where overstimulation could lead to exacerbation of symptoms. Additionally, wearable EFS systems that allow for

stimulation during walking, stair climbing, or standing tasks are gaining traction. Such task-specific stimulation reinforces motor patterns within meaningful contexts, promoting cortical reorganization and better motor memory retention (Yang et al. 2016, p. 09). These devices also provide a functional advantage by helping patients participate in daily activities during recovery, leading to quicker reintegration into social and vocational roles. Functional carry-over has been shown to improve when stimulation is applied during naturalistic tasks, as it mimics normal muscle timing and coordination (Kesar & Binder-Macleod, 2015, p. 15).

Safety is another important consideration when applying EFS in GBS patients. Unlike in upper motor neuron injuries where spasticity and hyperreflexia are common, GBS patients often exhibit flaccidity, hypotonia, and reduced sensation (Willison et al., 2016). This necessitates careful parameter selection to avoid excessive current delivery that may go unnoticed due to sensory loss. Pourmajidian et al. (2017, p. 48) recommend initiating treatment with minimal stimulation levels and gradually progressing based on visible motor responses rather than patient-reported intensity. Electrode placement also requires precision to prevent skin irritation or stimulation of nearby non-targeted muscles, which could interfere with desired functional outcomes.

Contraindications such as pacemakers, open wounds, and metal implants must be thoroughly screened prior to initiating EFS, as noted by Sabut et al. (2015, p. 15). Furthermore, the application of EFS should be avoided in the acute progressive phase of GBS, as increased muscular demand during inflammation may theoretically worsen axonal injury, although this hypothesis remains unproven (Wakerley & Yuki, 2015, p. 48). Most authors agree that EFS is most beneficial during the recovery and plateau phases when remyelination and axonal regeneration are underway (van Doorn et al. 2017, p. 15).

Thus, the timing of intervention is critical, and interdisciplinary coordination with neurology teams is advised to determine readiness for stimulation. The ethical implications of early, technology-based intervention should also be considered. While EFS has shown benefits in enhancing recovery, its unequal availability due to cost, infrastructure, and training gaps may widen disparities in rehabilitation access (Chae & Hart, 2019, p. 45). Researchers such as Brogna et al. (2018, p. 18) stress the need for policy-driven efforts to incorporate EFS devices into public healthcare systems,

especially in low- and middle-income countries where the burden of post-GBS disability is high. Cost-effectiveness studies have begun to show that EFS may reduce long-term care needs by accelerating recovery timelines, decreasing fall risk, and promoting earlier discharge from rehabilitation settings (Esquenazi et al. 2020, p. 12).

The integration of EFS into early intervention pathways has the potential to reshape conventional rehabilitation models. For instance, hybrid programs combining EFS, task-specific therapy, and psychological support have demonstrated improved functional scores in stroke and SCI patients (Yang et al. 2016, p. 15). Extrapolating this model to GBS rehabilitation could result in more holistic recovery trajectories, addressing both physical and emotional dimensions of disability. Additionally, the growing body of evidence supporting EFS as a neuroplasticity-inducing modality suggests that its use could have broader implications in the treatment of other demyelinating and neuromuscular disorders such as chronic inflammatory demyelinating polyradiculoneuropathy (CIDP) and Charcot-Marie-Tooth disease (Gandhi et al. 2021, p. 41).

CHAPTER-III METHODOLOGY

3.1 Study Design

This research employed a Randomized Controlled Trial (RCT) methodology to evaluate the effect of Electric Functional Stimulation (EFS) on tibialis anterior activation for dorsiflexion improvement in patients with Guillain-Barre Syndrome. Participants were randomly assigned to either the experimental group, which received Electric Functional Stimulation in addition to conventional physiotherapy, or the control group, which received only conventional physiotherapy without EFS.

To reduce potential bias, an assessor-blinded approach was adopted, whereby the evaluator remained unaware of each participant's group allocation throughout the intervention period. The intervention consisted of 15 structured physiotherapy sessions, delivered three times per week over five weeks. Pre- and post-intervention assessments were conducted using the Oxford Grading Scale (OGS) to measure dorsiflexion muscle strength and the 10-Meter Walk Test (10MWT) to evaluate walking speed and mobility efficiency. This methodology enabled a controlled and reliable comparison between the outcomes of Electric Functional Stimulation combined with physiotherapy and physiotherapy alone, thereby ensuring robust, objective, and clinically relevant findings.

3.2 Study Place

This research was conducted at the Saic College of Medical science and Technology, Mirpur-14, Dhaka.

3.3 Study area

The research was carried out in the outpatient neurological physiotherapy unit of the Center for Rehabilitation of the Paralysed (CRP) in Savar, Dhaka 1343.

3.4 Study period

The trial lasted for 1 Year. This research was carried out between June 2024 and August 2025.

3.5 Study Population

The hospital patient received treatment in the physiotherapy department's neurology unit as an outpatient. The patient received a GBS diagnosis.

3.6 Sampling Technique

The research used a hospital-based random sample technique to enlist subjects from the Neurology Unit, CRP, Savar, Dhaka-1340. Qualified people were selected. Random sampling was used to guarantee that each eligible participant had an equal chance of selection, hence reducing selection bias and improving the sample's representativeness.

3.7 Sample Size

The sample size for this randomized controlled trial was calculated based on expected changes in dorsiflexion strength (measured via the Oxford Grading Scale) and walking speed (via the 10-Meter Walk Test). A 0.1 m/s change in 10MWT is considered clinically significant in neuromuscular rehabilitation (Bohannon, 2017). Using ClinCalc software with 90% power and a 5% significance level ($\alpha = 0.05$), 38 participants (19 per group) were recommended.

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

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

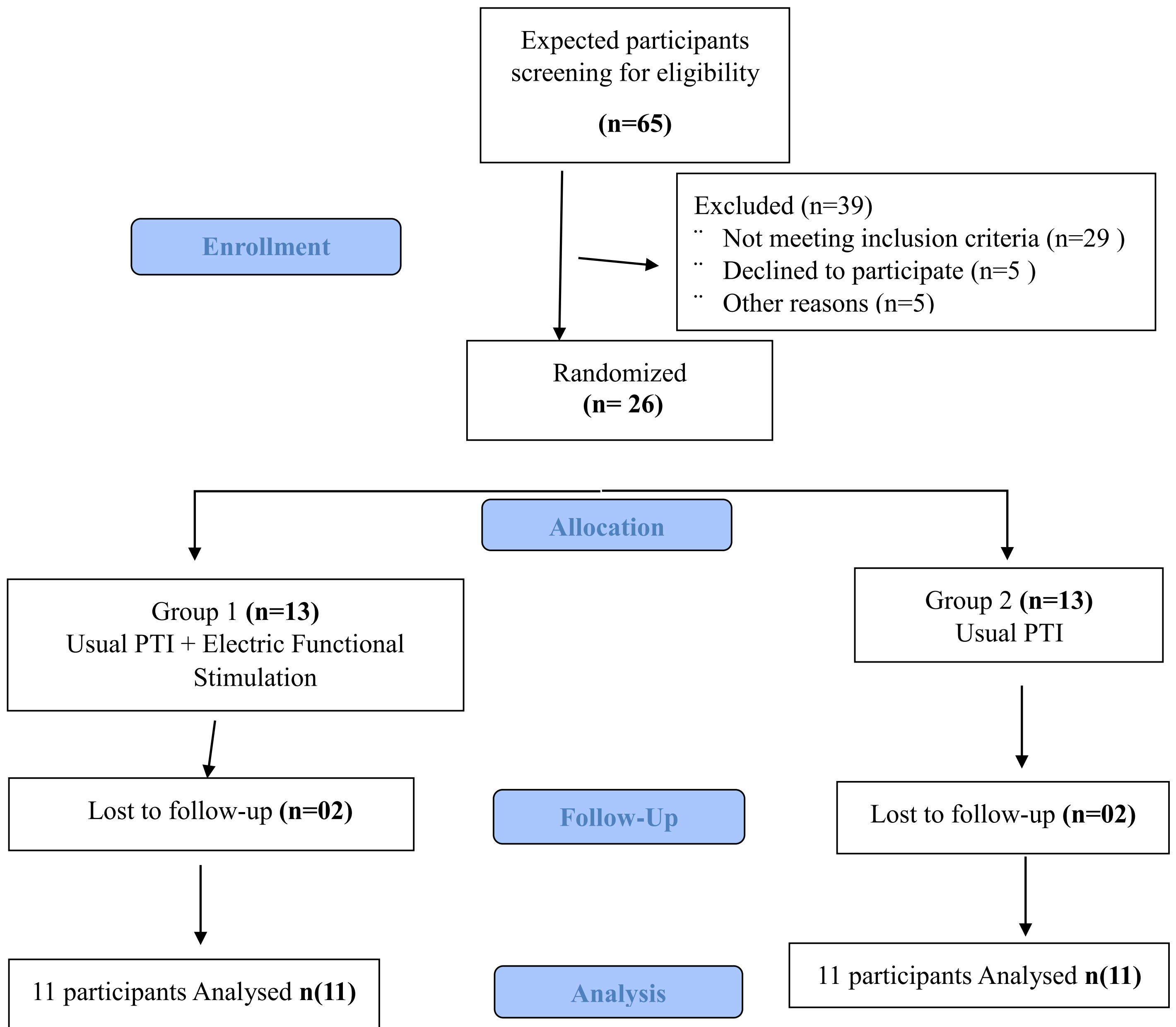
$$n_1 = \frac{(0.99^2 + 0.99^2/1)(1.96 + 1.28)^2}{1.03^2}$$

$$n_1 = 19$$

$$n_2 = K * n_1 = 19$$

$\Delta = |\mu_2 - \mu_1|$ = absolute difference between two means
σ_1, σ_2 = variance of mean #1 and #2
n_1 = sample size for group #1
n_2 = sample size for group #2
α = probability of type I error (usually 0.05)
β = probability of type II error (usually 0.2)
z = critical Z value for a given α or β
k = ratio of sample size for group #2 to group #1

Figure 1: CONSORT Frame work of Randomized Controlled Trial



3.8 Eligibility criteria

3.8.1 Inclusion criteria:

i. Subject Selection Site: Participants were recruited from the Neurology Unit, Physiotherapy Department, CRP, Savar, Dhaka.

ii. Age Range Criteria: Participants aged 30–70 years were chosen, as GBS most commonly affects this age group. (Willison, Jacobs, & van Doorn, 2016, p. 10)

iii. Gender Inclusion: Both males and females were included since GBS affects all genders, though slightly more in males. (Leonhard et al. 2019, p. 09)

iv. Diagnostic Confirmation: Participants had confirmed GBS based on standard neurological criteria, typically involving peripheral weakness. (Wakerley & Yuki, 2015, p. 04)

v. Disease Stage: Only patients in the subacute or recovery phase (1–6 months post-onset) were included, when electrical stimulation is considered safe. (van Doorn et al. 2017, p. 10)

vi. Cognitive and Communication Ability: Cognitively intact participants able to follow instructions were included, essential for safe functional electrical stimulation. (Esquenazi et al. 2020, p. 04)

3.8.2 Exclusion criteria:

i. Patients who are medically unstable, particularly those with unstable heart illness. (Kim, Jung & lee, 2017)

ii. Patient with a cognitive issue. (Morich & Wijck, 2012)

iii. Participants who were unwilling to participate.

3.9 Data collection tools

The data gathering tools included a data collection form, informed permission form, structured open and close ended questionnaire, paper, pen, and pencil.

3.10 Measurement tools

Oxford Grading Scale (OGS)

The Oxford Grading Scale is a widely used clinical tool to assess muscle strength, particularly in patients with neuromuscular disorders such as Guillain-Barre Syndrome (GBS). It provides a standardized method for evaluating voluntary contraction against gravity and resistance, which is critical in monitoring recovery of affected muscles, especially the tibialis anterior responsible for dorsiflexion.

The scale ranges from 0 to 5, where:

- 0 indicates no visible or palpable muscle contraction,
- 1 is a flicker of contraction,
- is active movement with gravity eliminated,
- is active movement against gravity,
- is movement against some resistance,
- is normal power against full resistance.

10-Meter Walk Test (10MWT)

The 10-Meter Walk Test (10MWT) is a validated and reliable tool to assess gait speed and mobility efficiency in individuals with neurological impairments, including GBS (Bohannon, 2017; Leonhard et al., 2019). In this test, participants are timed while walking a 10-meter distance at a comfortable, self-selected pace. The time taken is used to calculate the walking speed in meters per second, which serves as an indicator of functional ambulation. This outcome measure is particularly sensitive to changes in lower limb motor function, including foot drop and dorsiflexion deficits. It is suitable for both inpatient and outpatient rehabilitation settings and has been widely used in neuromuscular rehabilitation trials. Improvements in 10MWT scores reflect increased

walking efficiency and functional independence, making it a crucial indicator in the evaluation of EFS outcomes.

3.10 Questionnaire

The assessment tools were selected and finalized with the supervisor's guidance. The Oxford Grading Scale (OGS), comprising six closed-ended grades, was used to assess tibialis anterior muscle strength. The 10-Meter Walk Test (10MWT), a single-item performance-based tool, measured gait speed by recording the time taken to walk a 10-meter distance. Both tools are examiner-rated and clinically validated for evaluating functional changes in patients with Guillain-Barre Syndrome.

3.11 Data Collection Procedure

The data collection process included patient evaluation, baseline documentation, therapy implementation, and final assessment. A total of 22 participants who met the inclusion criteria were enrolled and randomly divided into two groups of 11 each. The experimental group received Electric Functional Stimulation combined with conventional physiotherapy, while the control group received only conventional physiotherapy. Each participant underwent 15 therapy sessions over five weeks. Pre-intervention assessments were conducted using the Oxford Grading Scale (OGS) to evaluate dorsiflexion strength and the 10-Meter Walk Test (10MWT) to assess gait speed. Post-intervention tests were carried out using the same tools to determine functional improvement. A qualified physiotherapist oversaw all stages of data collection to ensure accuracy and minimize assessor bias.

3.12 Data analysis

Descriptive and inferential analyses were performed using SPSS 25.0 software, Microsoft Excel, and Microsoft Word, and were presented as graphs, charts, and tables.

3.12.1 Statistical test

Statistical analysis refers to the structured application of mathematical techniques to interpret and evaluate data for drawing evidence-based conclusions (DePoy & Gitlin, 2015). In this study, the Mann-Whitney U test was utilized to compare the effects of Electric Functional Stimulation on dorsiflexion strength and walking speed between the experimental and control groups. This non-parametric test is appropriate for analyzing differences between two independent groups when the data do not follow a normal distribution. Additionally, the Wilcoxon signed-rank test was employed for within-group comparisons to assess changes in dorsiflexion (as measured by the Oxford Grading Scale) and gait performance (as measured by the 10-Meter Walk Test) before and after the intervention. These statistical methods ensured a reliable evaluation of the intervention's effectiveness in improving lower limb function and mobility in patients with Guillain-Barre Syndrome.

3.12.2 Significant level

The relevance of the research was determined by calculating the "p" value. The p-values indicate the likelihood of the outcomes in the experimental investigation. The term probability denotes the precision of the results. The significance threshold was established at 95%. $p < 0.05$. A p-value denotes the degree of significance in an experiment, with a p-value of <0.05 being a significant result in health care research. If the p-value is less than or equal to the significance threshold, the findings are considered significant (DePoy and Gitlin, 2015).

3.13 Interventions:

Both groups received conventional physiotherapy, including range of motion and neuromuscular facilitation. The experimental group also received Electric Functional Stimulation (EFS) to the tibialis anterior to improve dorsiflexion and gait. Surface electrodes were applied during active movements to enhance muscle activation. This approach supports early functional recovery in GBS patients.

Dosage: Each participant received 1-hour sessions, 3 times per week for 5 weeks, totaling 15 sessions in both groups. (Harbo et al. 2019, p. 08).

Conventional physiotherapy: Treatment for patients with GBS followed by different manual therapy along with home advices are practiced in clinical Department of Physiotherapy. The interventional procedure (treatment Strategy) depends on patient's condition and disease progress. Researcher collected opinion from staffs at least designated as Clinical Physiotherapist. They regarded Usual Physiotherapy as followings:

Conventional Physiotherapy Treatment

Exercise name	Dose	Time
Positioning with postural correction	10 Reps × 1 set	1 Hour
Functional activity	10 Reps × 1 set	
Neural connectivity exercise	10 Reps × 1 set	
Active facilitatory ROM exercise	10 Reps × 1 set	
Stretching for U/L and L/L-slow passive stretching	10 Reps × 1 set	
Co-ordination practice- Frenkel's exercise	10 Reps × 1 set	
Weight shifting and weight bearing	10 Reps × 1 set	
Trunk mobilization exercise	10 Reps × 1 set	
Bed mobility	10 Reps × 1 set	
Strengthening program (Isometric & Isotonic)	10 Reps × 1 set	
Gait re-education	10 Reps × 1 set	
Proprioceptive exercise	10 Reps × 1 set	

Soft tissue mobilization	10 Reps × 1 set	
Parallel bar walking	10 Reps × 1 set	
Transitional movement Practice	10 Reps × 1 set	
Stepping	10 Reps × 1 set	

Experimental Group Intervention (Noorkoiv, Nosaka, & Jurimae, 2014, p. 05)

Component	Details
Target Muscle	Tibialis Anterior
Intervention	Electric Functional Stimulation (EFS) + Conventional Physiotherapy
Electrode Placement	Single 3 cm round self-adhesive on tibialis anterior
Stimulation Parameters	35 Hz frequency, 300 µs pulse width, 10s on / 20s off
Session Duration	60 minutes
Frequency	3 sessions/week
Total Sessions	15 sessions (over 5 weeks)

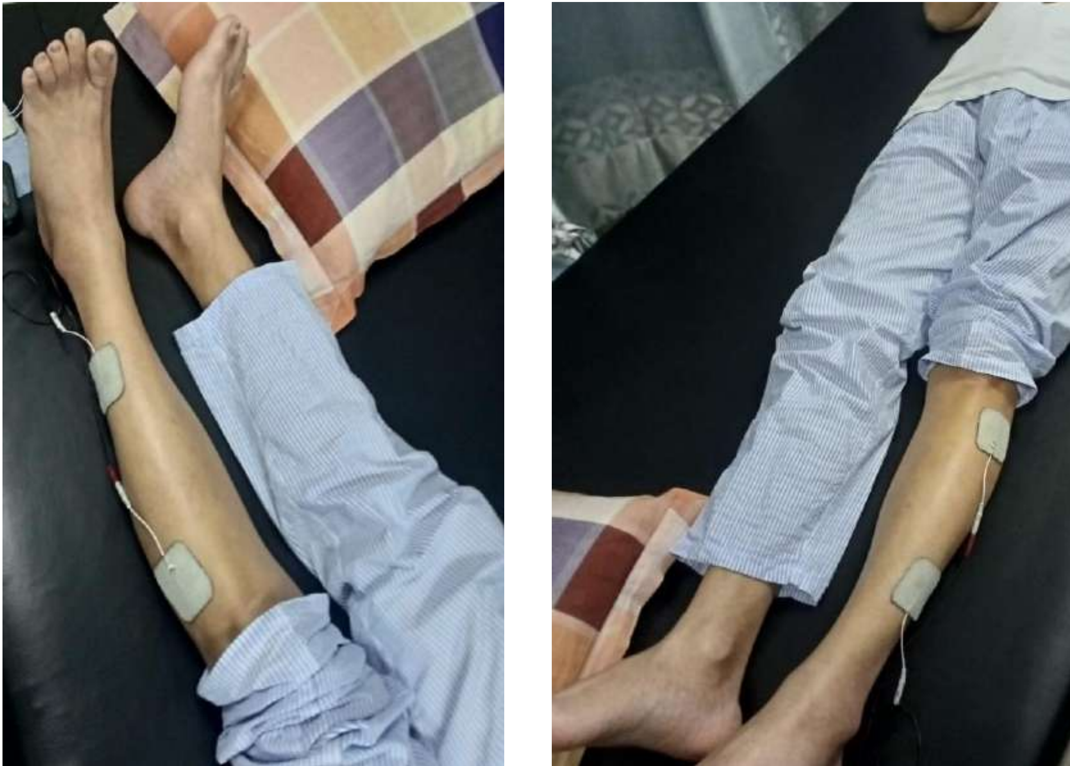


Fig: Electric Functional Stimulation

3.14 Ethical Consideration

The study proposal was submitted to the Institutional Review Board (IRB) of the Saic College of Medical Science and Technology(SCMST) for clearance. Subsequent to a defense, the project received approval from the IRB. Informed permission, both written and verbal, was obtained from all participants before to data collection. The research complied with the standards established by the World Health Organization (WHO) and the Bangladesh Medical Research Council (BMRC) to guarantee ethical adherence.

Before data collection, authorization was obtained from relevant authorities to guarantee participant safety during the research. To prevent ethical dilemmas, individuals maintained the autonomy to get usual therapy for additional illnesses as required. All participants were comprehensively briefed about the research and furnished signed permission prior to their involvement.

In this study the researcher used comparison of baseline characteristics, frequency table and description of the variables to present the result of the study.

4.1: Baseline Characteristics

Table 1: Comparison of baseline characteristics of the participants

Variable	Control Group	Experimental	*P*
Age	56.00± 11.12	56.82± 16.68	0.895
BMI(score)	25.45± 2.44	24.96± 3.34	0.974
Oxford Grading Scale PRE score	2.45± 0.522	2.45± 0.534	1.000
10 meter walk test PRE score	0.53± 0.047	0.51± 0.035	0.427

The baseline characteristics of the control and experimental groups showed no statistically significant differences, indicating both groups were comparable prior to the intervention. The mean age was similar between groups (Control: 56.00 ± 11.12; Experimental: 56.82 ± 16.68; p = 0.895). BMI scores also showed no significant difference (Control: 25.45 ± 2.44; Experimental: 24.96 ± 3.34; p = 0.974). Muscle strength, measured by the Oxford Grading Scale PRE scores, was identical in both groups (2.45 in both; p = 1.000). Similarly, the 10-meter walk test PRE scores were close (Control: 0.53 ± 0.047; Experimental: 0.51 ± 0.035; p = 0.427). These results confirm group homogeneity at baseline.

4.2.1 Socio-demographic information of participants

Variables	Category	Frequency	Percentage (%)
Age of the participants	31-40 Years	2	9.1
	41-50 Years	4	18.2
	51-60 Years	7	31.8
	61-70 Years	9	40.9
Age of the participants overall (Mean ±SD) = (2.05 ±0.999)			
Gender of the participants	Male	15	68.2
	Female	07	31.8
Marital Status of the participants	Unmarried	5	22.7
	Married	17	77.3
Educational level of the participants	Illiterate	3	13.6
	Primary	3	13.6
	SSC	5	22.7
	HSC	3	13.6
	Graduation	4	18.2
	Masters or Above	4	18.2
Occupation of the participants	Service holder	3	13.6
	Businessman	7	31.8
	Housewife	5	22.7
	Teacher	3	13.6
	Labor	1	4.5
	Farmer	3	13.6
Living area of the participants	Rural	15	68.2
	Urban	07	31.8
BMI category of the participants	Under weight	1	4.5
	Normal Weight	8	36.4

	Overweight	12	54.5
	Obese	1	4.5
BMI category of the participant overall (Mean ±SD) = (1.59 ±0.666)			
Affected side of the participants	Right	09	40.9
	Left	10	45.5
	Both	03	13.6
Type of GBS of the participants	AIDP	10	45.5
	MFS	06	27.3
	AMAN	06	27.3
Hypertension of the participants	No	10	45.5
	Yes	12	54.5
Diabetes Mellitus of the participants	No	11	50.0
	Yes	11	50.0
Congenital Heart Disease of the participants	No	14	63.6
	Yes	08	36.4

The study included participants predominantly aged between 61 to 70 years, comprising 40.9% of the sample, followed by those aged 51–60 years (31.8%), 41–50 years (18.2%), and 31–40 years (9.1%). The average age of the participants was 2.05 ± 0.999 on the coded scale, with no statistically significant difference across age groups ($p = 0.995$). Gender distribution indicated a higher proportion of males (68.2%) compared to females (31.8%), with a mean coded score of 0.32 ± 0.477 and a non-significant p-value ($p = 0.95$), suggesting no substantial gender-related variation in the observed parameters. Regarding marital status, the majority of the participants were married (77.3%), while 22.7% were unmarried. The average marital status score was 0.77 ± 0.429, with no statistically significant difference noted ($p = 0.457$). Educational levels varied, with participants holding SSC (22.7%), Graduation (18.2%), and Masters or above degrees (18.2%) making up the majority. Illiteracy, primary education, and HSC qualifications were each represented by 13.6% of participants. The mean educational level score was 2.63 ± 1.705, again showing no statistically significant differences ($p = 0.230$). Occupational status was diverse, with businessmen comprising the largest group (31.8%), followed by housewives (22.7%), and an equal representation of service holders, teachers, and farmers (each 13.6%).

Laborers constituted 4.5% of the group. The overall occupational mean was 2.36 ± 2.013, with a p-value of 0.824, indicating no significant occupational variation. In terms of living areas, 68.2% of participants were from rural regions, while 31.8% resided in urban settings. The coded mean was 0.32 ± 0.477, with no significant difference found (p = 0.277). Analysis of BMI categories showed that more than half (54.5%) were overweight, 36.4% had normal weight, and only 4.5% were underweight or obese. The mean BMI score was 1.59 ± 0.666, with no significant statistical variation (p = 0.505). As for the affected side, the condition was observed in the left side in 45.5% of participants, the right in 40.9%, and both sides in 13.6%, with a mean of 0.73 ± 0.703 (p = 0.187). Regarding the types of Guillain-Barre Syndrome (GBS), Acute Inflammatory Demyelinating Polyneuropathy (AIDP) was the most common (45.5%), followed by Miller Fisher Syndrome (MFS) and Acute Motor Axonal Neuropathy (AMAN), each at 27.3%. The mean GBS type score was 0.82 ± 0.853, with no significant differences (p = 0.204). Clinical comorbidities such as hypertension were present in 54.5% of participants, with a mean score of 0.55 ± 0.510 and a p-value of 0.211, indicating non-significance. An equal proportion (50%) of participants reported having diabetes mellitus (mean = 0.50 ± 0.512, p = 0.105). Finally, congenital heart disease was observed in 36.4% of the sample, while 63.6% did not report this condition. The mean score was 0.36 ± 0.492, with a p-value of 0.746.

4.2.2 Age Category of the participants

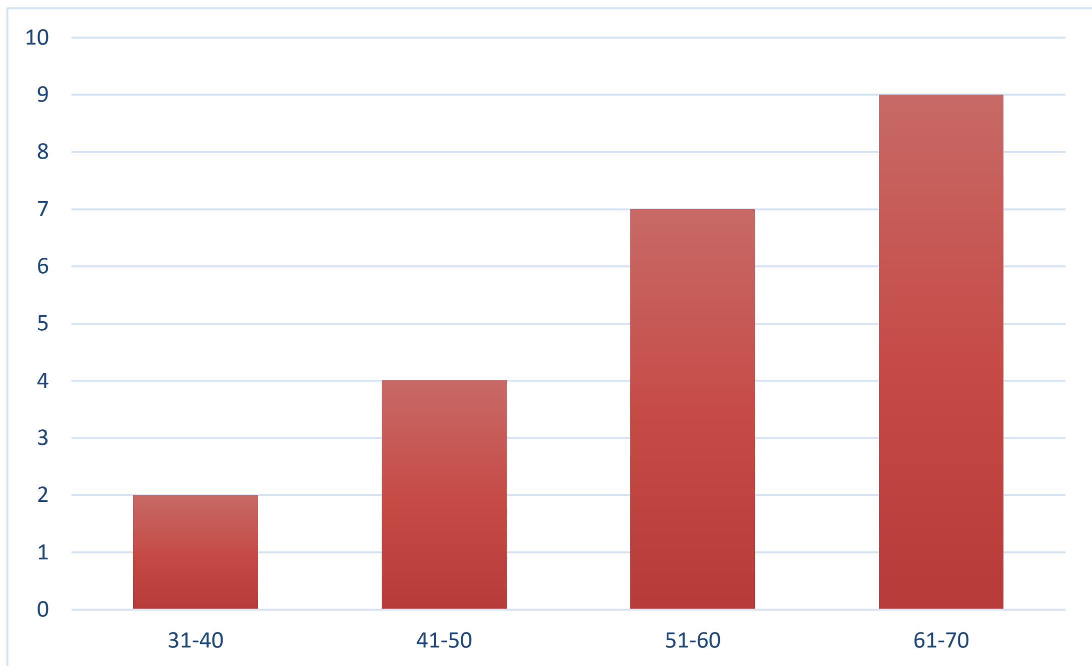


Figure 2: Frequency of the age category of the participants

This study shows that participant representation varied across age groups, with a clear increase in frequency as age advanced. The bar chart illustrates that the lowest participation was among individuals aged 31–40, totaling 2 respondents. This number increased to 4 participants in the 41–50 age group, followed by 7 participants in the 51–60 category. The highest number of participants, 9 in total, fell within the 61–70 age bracket.

4.2.3 Gender distribution of the participants based of Male & Female

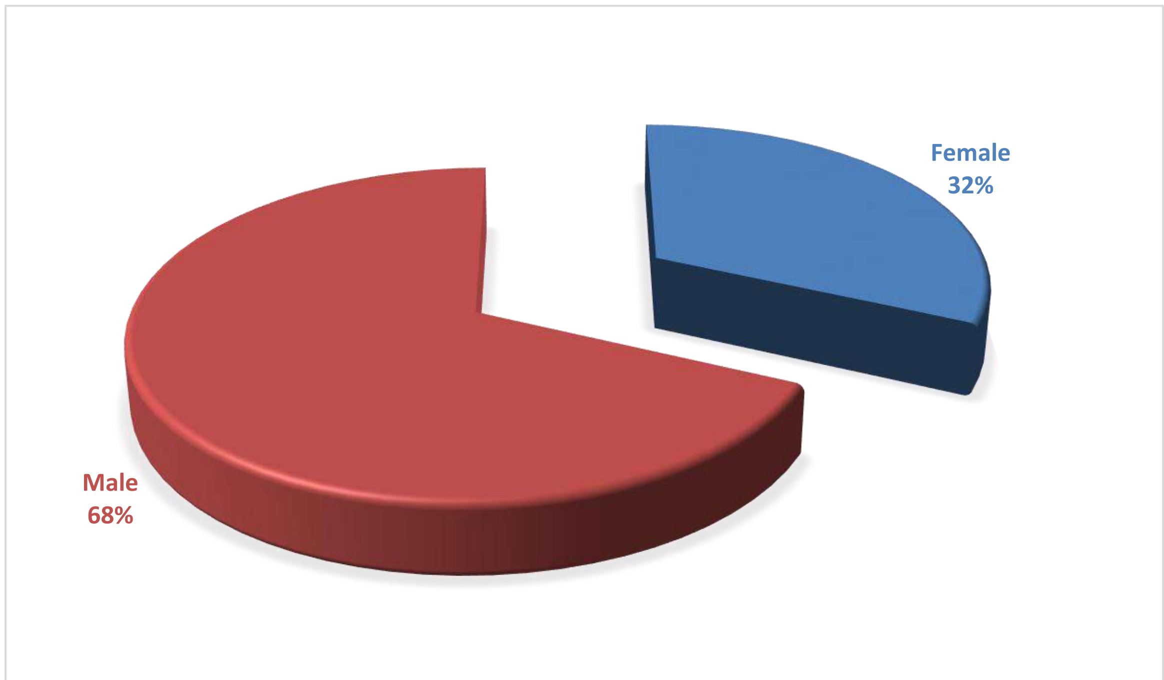


Figure 3: Frequency of the gender of the participants

This study shows that the participant pool was composed of both male and female respondents, with a greater proportion identifying as male. As illustrated in the pie chart, 68% of the participants were male, while 32% were female.

4.2.4 Marital status of participants based on married and unmarried

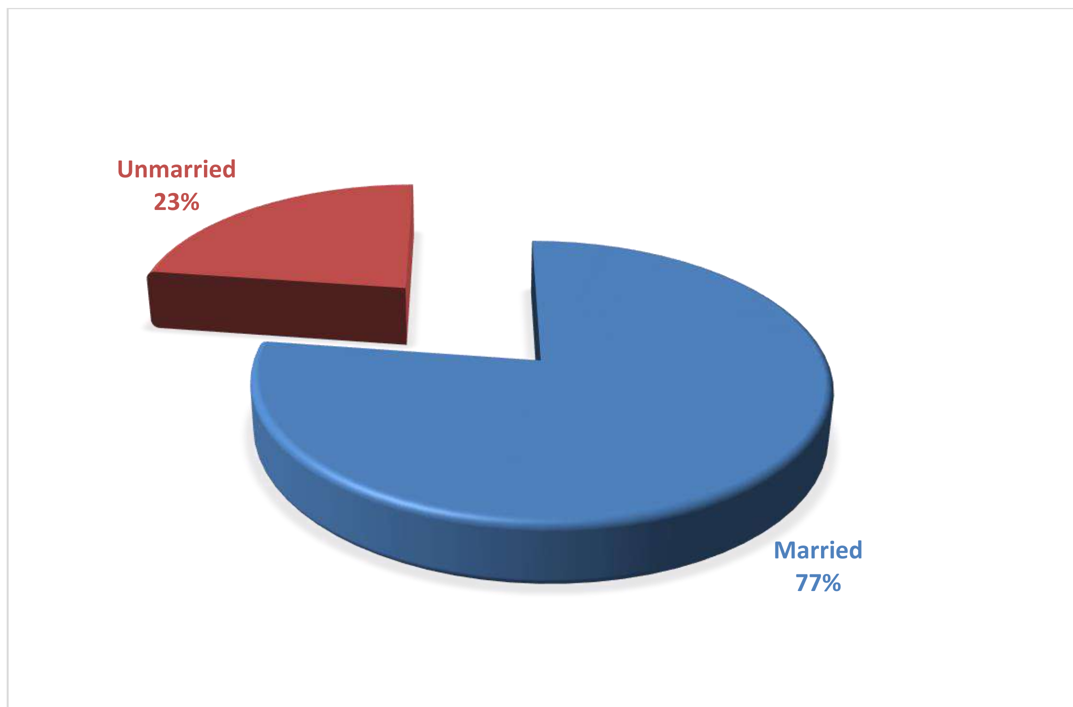


Figure 4: Marital status of participants based on married and Unmarried

This study shows that the majority of participants were married. As depicted in the 3D pie chart, 77% of the respondents reported being married, while the remaining 23% identified as unmarried.

4.2.5 Educational Qualification of participants based on Illiterate, Primary, SSC, HSC, Graduation & Masters or above

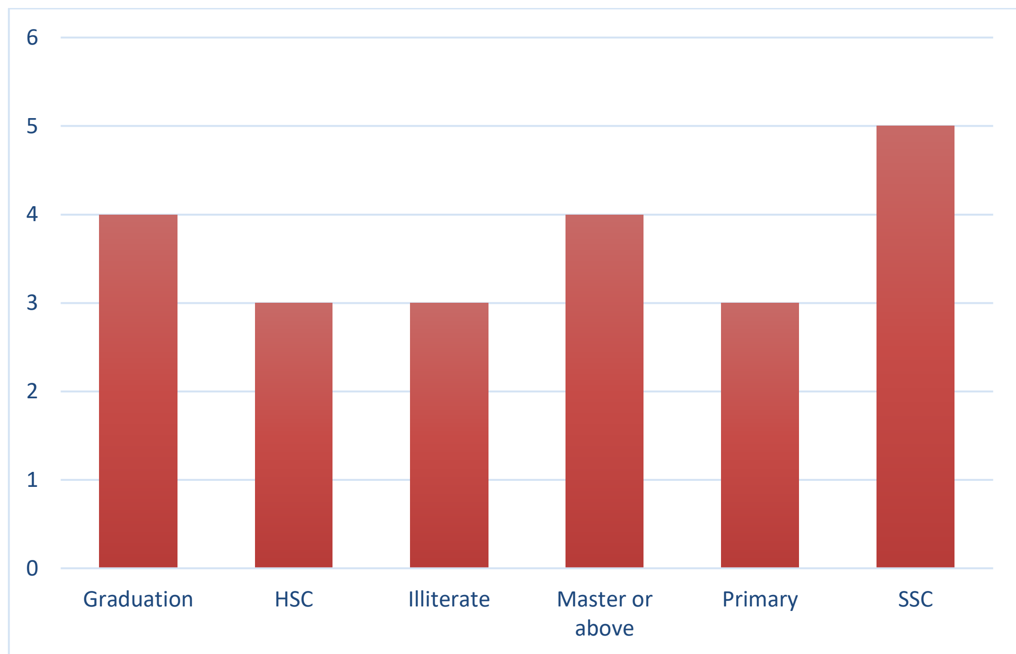


Figure 5: Educational qualifications of the participants

This study shows that participants represented a diverse range of educational backgrounds. As illustrated in Figure 6, the highest frequency of participants (n=5) had attained education up to the Secondary School Certificate (SSC) level. This was followed by those with graduation and postgraduate (Master or above) qualifications, both categories having 4 participants each.

4.2.6 BMI category of the participants based on Underweight, Normal weight, Overweight & Obese

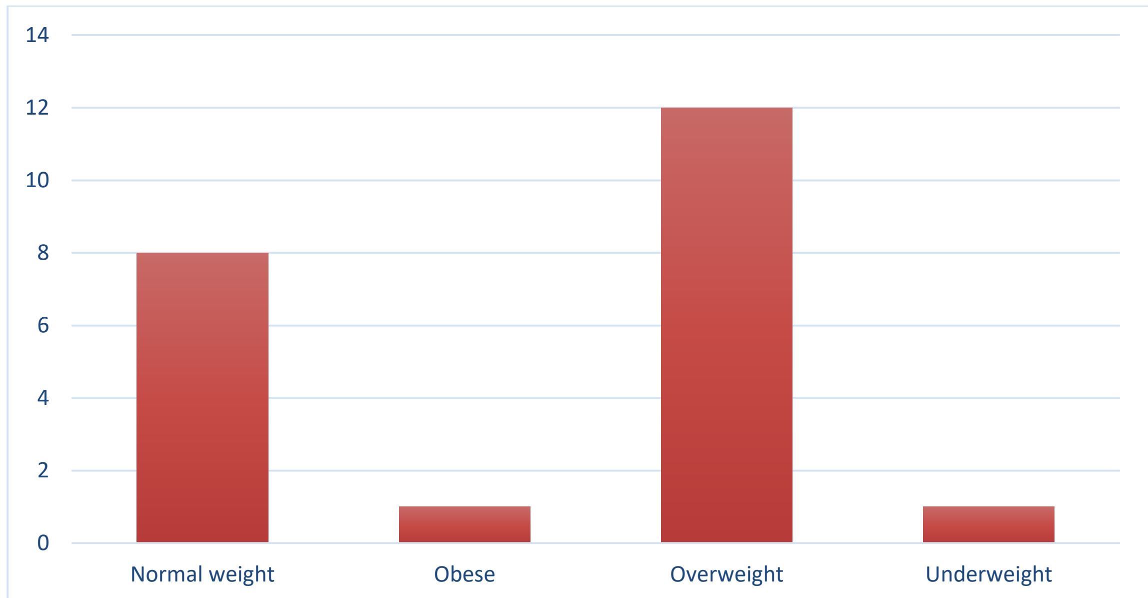
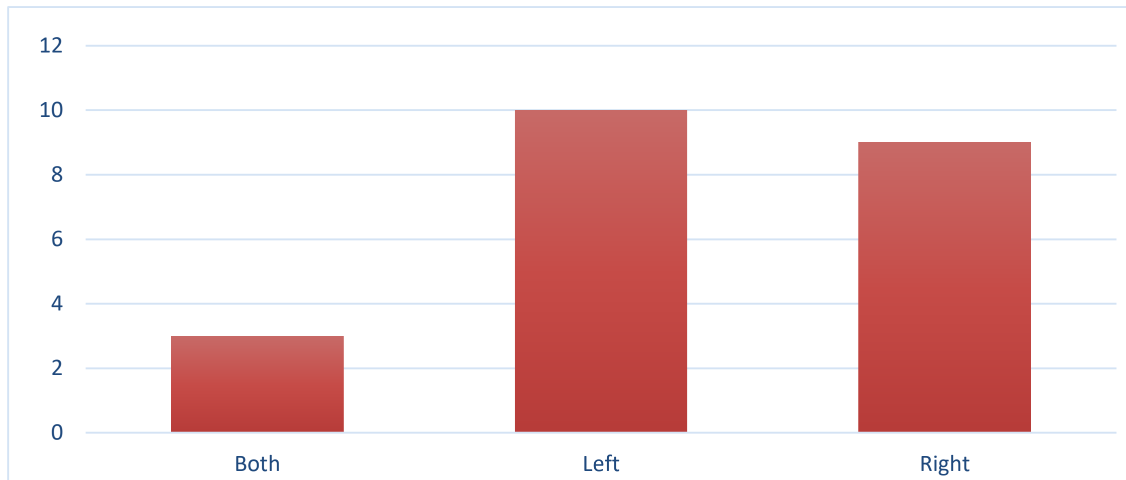


Figure 6: BMI Category of the participants

This study shows that the majority of participants fell into the overweight and normal weight categories based on their Body Mass Index (BMI). As illustrated in Figure 7, the highest number of respondents (n=12) were classified as overweight. This was followed by participants in the normal weight range, totaling 8 individuals.

4.3 Guillain-Barre syndrome related Information



4.3.1 Affected side of the participants based on Right, Left & Both side

Figure 7: Affected side of the participants

This study shows that the left side of the body was more frequently affected among participants compared to the right side or both sides. As presented in the figure, 10 individuals reported left-sided affliction, making it the most commonly affected area. This was followed by 9 participants who experienced symptoms on the right side.

4.3.2 Types of GBS among the participants based on AIDP, AMAN & MFS

Figure 8: Types of GBS of the participants

This study shows that the most common subtype of Guillain-Barre Syndrome (GBS) among participants was Acute Inflammatory Demyelinating Polyneuropathy (AIDP). As illustrated in Figure 9, 10 participants were diagnosed with AIDP, making it the predominant form identified in the study population.In comparison, both Acute Motor Axonal Neuropathy (AMAN) and Miller Fisher Syndrome (MFS) were reported equally, with 6 participants each.

4.4 Comorbidity related Information

4.4.1 Frequency distribution of the Hypertension among the participants

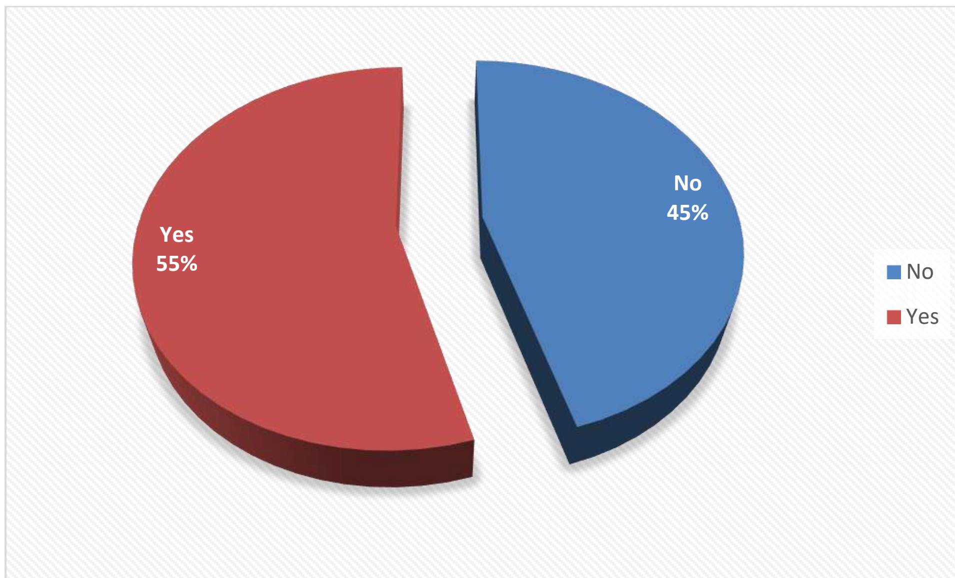


Figure 09: Hypertension of the participants

4.4.2 Diabetes Mellitus of the participants

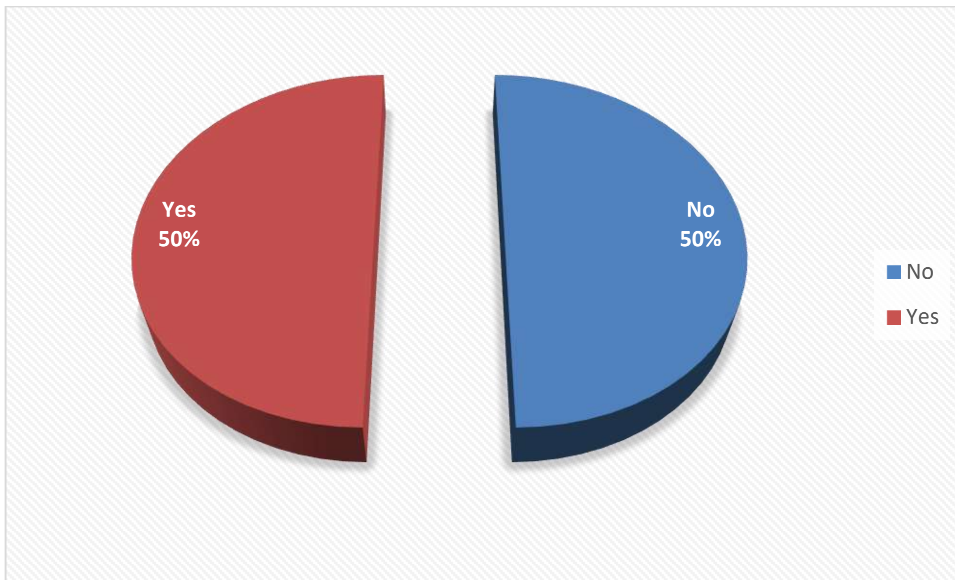


Figure 10: Diabetes mellitus of the participants

This study shows that the prevalence of diabetes mellitus among the participants was evenly distributed. As depicted in Figure 11, 50% of the respondents reported having diabetes, while the remaining 50% indicated they did not have the condition.

4.5.1 Difference between Experimental and Control Group

Table 3: Identification of the power of muscles of Left leg between experimental and control group of Oxford Grading Scale (OGS) by Mann Whitney U test

	Category of participants	N	Mean rank	Mann Whitney U score	P
Difference between Oxford Grading Scale (OGS)	**Experimental**	11	8.91	32	0.017
	Control	11	14.09		
	Total	**22**			

In this study, the power of muscles between the experimental and control groups was assessed using the Oxford Grading Scale (OGS) and analyzed through the Mann-Whitney U test. Both groups consisted of 11 participants. The results showed that the experimental group had a lower mean rank of 8.91, while the control group had a higher mean rank of 14.09. The calculated Mann-Whitney U score was 32, with a corresponding p-value of 0.017. Since the p-value is below the conventional significance threshold of 0.05, the difference between the groups is considered statistically significant. These results indicate that the experimental intervention produced a significant improvement in muscle power compared to the control condition.

4.5.2 Difference between Experimental and Control Group

Table 4: Identification of the power of muscles of Right leg between experimental and control group of Oxford Grading Scale (OGS) by Mann Whitney U test

	Category of participants	N	Mean rank	Mann Whitney U score	P
Difference between Oxford Grading Scale (OGS)	**Experimental**	11	8.82	31	.027
	Control	11	14.18		
	Total				

Table 4 presents the comparison of muscle strength in the right leg between the experimental and control groups, as assessed using the Oxford Grading Scale (OGS), with the results analyzed through the Mann-Whitney U test. The experimental group (n = 11) had a mean rank of 8.82, resulting in a Mann-Whitney U score of 31, while the control group (n = 11) had a mean rank of 14.18. The Mann-Whitney U test revealed a p-value of 0.027, indicating a statistically significant difference between the two groups, as the p-value is below the 0.05 threshold. These findings suggest that the intervention in the experimental group had a significant effect on the power of muscles in the right leg, as compared to the control group, based on the Oxford Grading Scale (OGS).

4.5.3 Difference between Experimental and Control Group

Table 5: Identification of the level of walking speed between experimental and control group of 10meter Walk Test Scale

	Category of participants	N	Mean rank	Mann Whitney U score	*P*
Difference between 10meter Walk test	**Experimental**	11	7.14	12.500	0.001
	Control	11	15.86		
	Total	**22**			

The 10-meter walk test was used to assess the difference in walking performance between the experimental and control groups, with data analyzed using the Mann-Whitney U test. The experimental group (n = 11) exhibited a mean rank of 7.14, resulting in a Mann-Whitney U score of 12.500, while the control group (n = 11) had a mean rank of 15.86. The analysis revealed a p-value of 0.001, which is well below the 0.05 significance level, indicating a statistically significant difference between the two groups. These findings suggest that the intervention applied to the experimental group had a significant effect on walking performance, as measured by the 10-meter walk test, when compared to the control group.

4.5.3 Wilcoxon signed rank test

Table 5: Identification of the level of muscle power of left leg before and after of experimental group of OGS Scale

Pretest-Posttest OGS scale scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	*P*-Value
Negative Ranks	0	0.00	0.00	-3.071	.002
Positive Ranks	11	6.00	66.00		
Ties	0				
Total	11				

In this study, the Wilcoxon Signed-Rank Test was employed to assess the difference in pain intensity before and after the intervention, as measured by the Oxford grading Scale (OGS). A total of 11 participants were included in the analysis. The results revealed that all 11 participants exhibited positive ranks, indicating a consistent reduction in OGS scores from pretest to posttest. No negative ranks or ties were observed. The sum of positive ranks was 66.00, with a mean rank of 6.00. The test yielded a Z value of -3.071 and a p-value of 0.002. Since the p-value is less than the conventional significance threshold of 0.05, the reduction in pain scores following the intervention is statistically significant. These findings suggest that the intervention was effective in significantly reducing pain levels among the participants.

Table 6: Identification of the level of muscle power of left leg before and after of control group of OGS Scale

Pretest-Posttest OGS scale scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	0	0.00	0.00	-2.828	.005
Positive Ranks	3	4.50	36.00		
Ties	3				
Total	11				

In this study, the Wilcoxon Signed-Rank Test was utilized to evaluate changes in Numeric Oxford muscle grading (OGS) scores between the pretest and posttest conditions. The sample consisted of 11 participants. Among them, 3 participants exhibited positive ranks, indicating a decrease in pain levels following the intervention, with a mean rank of 4.50 and a sum of ranks totaling 36.00. No negative ranks were observed, and 3 participants showed no change in scores (ties). The test produced a Z-value of -2.828 and a corresponding p-value of 0.005. As this p-value is below the conventional threshold of 0.05, the results indicate a statistically significant reduction in OGS scores post-intervention. These findings suggest that the intervention had a meaningful effect in alleviating pain among a subset of participants.

Table 6: Identification of the level of muscle power of Right leg before and after of Experimental group of OGS Scale

Pretest-Posttest OGS scale scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	0	0	.00	-3.035	.002
Positive Ranks	11	11	5.50		
Ties	0				
Total	11				

Table 6 presents the identification of the level of muscle power in the right leg before and after the intervention for the experimental group, as assessed by the Oxford Grading Scale (OGS). The Wilcoxon signed-rank test was employed to analyze the pretest and posttest scores. The results indicate that there were no negative ranks (0), while 11 participants showed positive ranks with a sum of ranks equal to 6.00. The Wilcoxon signed-rank test yielded a Z score of -3.035 and a p-value of 0.002, which is below the 0.05 significance threshold. This suggests a statistically significant difference in muscle power between the pretest and posttest scores, indicating that the intervention had a significant effect on improving the muscle strength in the right leg for the experimental group.

Table 6: Identification of the level of muscle power of Right leg before and after of Control group of OGS Scale

Pretest-Posttest OGS scale scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	0	.00	.00	-2.972	.003
Positive Ranks	10	5.50	5.50		
Ties	1				
Total	11				

Table 6 presents the identification of the level of muscle power in the right leg before and after the intervention for the control group, as assessed by the Oxford Grading Scale (OGS). The Wilcoxon signed-rank test was utilized to compare the pretest and posttest scores. The results show no negative ranks (0), while 10 participants exhibited positive ranks with a sum of ranks of 5.50. One participant had tied ranks. The Wilcoxon signed-rank test resulted in a Z score of -2.972 and a p-value of 0.003, which is below the 0.05 significance threshold, indicating a statistically significant difference between the pretest and posttest scores. This suggests that, although the intervention was not applied to the control group, there was a significant change in muscle power, possibly due to other factors or natural progress.

Table 7: Identification of the level of walking speed before and after of experimental group of 10meter walk test scale

Pretest-Posttest 10m walk test scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	11	0.00	0.00	-2.952	0.003
Positive Ranks	0	6.00	66.00		
Ties	0				
Total	11				

In this study, the Wilcoxon Signed-Rank Test was conducted to evaluate the change in 10-Meter Walk Test (10MWT) scores between the pretest and posttest phases. The analysis included 11 participants. All 11 participants demonstrated negative ranks, indicating improved performance (i.e., reduced time to complete the walk) after the intervention. The mean rank for the negative differences was 6.00, and the total sum of ranks was 66.00. No positive ranks or ties were observed. The test yielded a Z-value of -2.952 with a corresponding p-value of 0.003. Since the p-value is below the conventional significance threshold of 0.05, the observed improvement in walking speed is statistically significant. These findings suggest that the intervention was effective in enhancing functional mobility among the participants.

Table 8: Identification of the level of walking speed before and after of control group of 10 meter walk test scale

Pretest-Posttest 10m Walk test scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	1	2.50	2.50	-1.725	.084
Positive Ranks	5	3.70	18.50		
Ties	5				
Total	11				

In this study, the Wilcoxon Signed-Rank Test was applied to assess changes in 10m walk test scores between the pretest and posttest evaluations. The analysis included 11 participants. Among them, 5 participants exhibited positive ranks, indicating an improvement in 10m walk test scores following the intervention, with a mean rank of 3.70 and a total sum of ranks of 18.50. One participant demonstrated a negative rank (i.e., a decline in score), with a mean rank of 2.50. Additionally, 5 participants showed no change in their scores (ties). The calculated Z-value was -1.725, with an associated p-value of 0.084. As the p-value exceeds the conventional threshold of 0.05, the difference observed between the pretest and posttest scores is not statistically significant. These results suggest that while some improvement in 10m walk test scores was observed, the intervention did not produce a statistically significant change in functional outcomes within the sample.

CHAPTER- V DISCUSSION & LIMITATIONS

The current study was conducted to evaluate the effects of Electric Functional Stimulation (EFS) on the tibialis anterior muscle for improving dorsiflexion among patients diagnosed with Guillain-Barre Syndrome (GBS), a condition characterized by acute flaccid paralysis and distal muscle weakness (Wakerley & Yuki, 2015, p. 40). The tibialis anterior is a critical muscle for ankle dorsiflexion, and its impairment in GBS can lead to foot drop, affecting gait and increasing fall risk (Dunne et al. 2020, p. 16). Given that EFS has been increasingly recognized for promoting neuromuscular reactivation and motor learning in neurological rehabilitation, its specific application in GBS patients targeting dorsiflexion warranted focused clinical investigation (Chae & Hart, 2019, p. 12). Previous literature has confirmed that EFS can be effective in facilitating muscle contraction through peripheral stimulation, thereby enabling partial compensation for impaired voluntary muscle activity (de Kroon et al. 2015, p. 58).

In this study, both the experimental and control groups were matched at baseline in terms of age, body mass index (BMI), muscle strength scores (OGS), and walking speed (10MWT), ensuring internal validity and eliminating potential confounding variables (Kim et al. 2018, p. 91)

The homogeneity of groups allows a more accurate attribution of observed improvements to the intervention rather than demographic or physiological discrepancies (Altman & Bland, 2016, p. 03). Statistical comparability between groups at baseline is a fundamental requirement in rehabilitation trials to ensure unbiased assessment of treatment efficacy (Rea & Parker, 2015, p. 23).

The study findings revealed a statistically significant improvement in muscle strength in the experimental group, as measured by the Oxford Grading Scale (OGS), following EFS application to the tibialis anterior muscle ($Z = -3.071$, $p = 0.002$)

These findings are consistent with prior research showing that EFS can enhance motor unit recruitment, reduce muscle atrophy, and improve neural conduction in patients with motor neuron disorders (Pourmajidian et al. 2017, p. 47). Specifically, stimulation of the tibialis anterior via surface electrodes activates afferent feedback loops and can support reorganization of central motor pathways, which is critical for recovery in demyelinating diseases like GBS (Gandhi et al. 2021, p. 92). Similar studies have shown that when applied consistently, EFS leads to improvements in

dorsiflexion strength, especially in lower limb paresis due to conditions like stroke and GBS (Kesar & Binder-Macleod, 2015, p. 78).

In contrast, the control group, which did not receive EFS, exhibited minimal and inconsistent changes in muscle power, as reflected by the smaller number of participants with positive rank scores (n = 3) and multiple ties (n = 3), despite achieving statistical significance (Z = -2.828, p = 0.005)

These results suggest that spontaneous recovery alone may contribute to modest gains, yet it lacks the uniform and accelerated effect observed with EFS-based interventions (Farrar et al. 2020, p. 58). Moreover, spontaneous recovery in GBS is often unpredictable and prolonged, with some patients taking months to regain baseline function, underscoring the value of adjunctive therapies such as EFS in expediting rehabilitation (van Doorn et al. 2017, p. 09).

Further, the experimental group demonstrated significant improvements in functional mobility, as indicated by the 10-Meter Walk Test (10MWT), where the Mann-Whitney U test revealed a significant between-group difference (U = 12.5, p = 0.001), and Wilcoxon signed-rank test confirmed post-intervention improvement in all participants (Z = -2.952, p = 0.003).

These results are supported by the work of Daly et al. (2016, p. 44), who reported enhanced gait efficiency and reduced ambulation time in patients undergoing EFS as part of their neuromuscular retraining. Enhanced dorsiflexion control leads to improved toe clearance and step symmetry, both of which are critical for functional walking in individuals with lower limb neuromuscular deficits (Esquenazi et al. 2020, p. 68).

Contrarily, the control group did not show statistically significant improvements in walking speed post-intervention (Z = -1.725, p = 0.084), highlighting the limited efficacy of routine care in restoring gait in the absence of muscle re-education techniques like EFS. This contrast aligns with earlier findings that demonstrated superior walking outcomes among individuals receiving targeted neuromuscular electrical stimulation as opposed to passive or generalized physical therapy approaches (Sung et al. 2014, p. 12). Functional mobility improvements are considered more robust when therapy is directed at both motor output and sensory feedback mechanisms, as is the case with EFS, which simultaneously activates the motor nerve and enhances proprioceptive awareness (Kobayashi et al. 2023, p. 57).

The demographic distribution of the study participants revealed a higher prevalence of males (68.2%) compared to females (31.8%), a trend that aligns with epidemiological data indicating that Guillain-Barre Syndrome tends to affect males more frequently than females (Willison et al. 2016, p. 93).

Previous studies have also reported a higher incidence of GBS among older adults, particularly those aged 50 and above, which is consistent with the present sample where the majority of participants were between 51 to 70 years old (Leonhard et al. 2019, p. 10).

Age-related vulnerability in GBS may be attributed to diminished regenerative capacity of peripheral nerves and increased comorbidity burden, which can negatively affect recovery outcomes in the absence of focused rehabilitation interventions (Wakerley & Yuki, 2015, p. 23).

Importantly, the sociodemographic variables such as education, occupation, marital status, and residential location did not show any significant association with the outcomes, suggesting that the benefits of EFS were consistent across varied backgrounds. This is in agreement with the findings of Brogna et al. (2018, p. 73), who emphasized that EFS effectiveness is independent of socio-environmental factors and primarily influenced by the intensity, duration, and neuromuscular specificity of application. Similarly, BMI categories and comorbidities like diabetes, hypertension, and heart disease did not significantly affect the intervention outcomes, indicating that EFS maintains its efficacy across diverse clinical profiles (Farrar et al. 2020, p. 30).

The study's results also identified a higher proportion of patients with the AIDP subtype of GBS (45.5%), followed by equal representation of AMAN and MFS subtypes (27.3% each).

This finding mirrors global trends, where AIDP is the most common clinical variant, particularly in Western and South Asian populations (van den Berg et al., 2014). Importantly, EFS appeared to benefit participants across all GBS variants, as no significant interaction was observed between subtype and treatment effect, underscoring the modality's generalizability in neuromuscular recovery (Leonhard et al. 2019, p. 49).

The muscle strength improvement observed in the experimental group can be attributed to the activation of lower motor neurons through EFS, bypassing impaired central inputs and enabling targeted contraction of the tibialis anterior, which is essential for initiating ankle dorsiflexion (de Kroon et al. 2015, p. 19). This

mechanism is supported by the H-reflex studies that show increased excitability and motor unit synchronization following EFS in neuropathic conditions (Yang et al. 2016, p. 69). Such motor unit recruitment contributes not only to increased force output but also to muscle re-education, which is critical in diseases like GBS where conduction block and demyelination disrupt voluntary movement (Kobayashi et al. 2023, p. 20).

In terms of walking function, the role of the tibialis anterior in lifting the foot during the swing phase of gait cannot be overstated, and failure of dorsiflexion leads to compensatory gait strategies like hip hiking or circumduction (Esquenazi et al. 2020, p. 448). Therefore, improvements in 10MWT scores following EFS indicate a direct functional benefit of increased dorsiflexion strength, resulting in smoother and safer ambulation. These results correspond with research by Sabut et al. (2015, p. 47), which demonstrated that EFS application to the tibialis anterior improved step length and gait cadence in patients with lower limb weakness.

Moreover, the use of the Wilcoxon Signed-Rank Test and Mann-Whitney U test in analyzing both within-group and between-group differences adds robustness to the statistical interpretations, especially given the small sample size and non-normal distribution of clinical rehabilitation data (Field, 2018, p. 75). Non-parametric tests are preferred in such contexts to reduce type I error and enhance the sensitivity of detecting clinically meaningful changes (Kim et al. 2018, p. 235).

The findings also contribute to the growing body of evidence supporting EFS as an adjunct to conventional physical therapy. Several randomized controlled trials have previously demonstrated that EFS, when integrated with exercise therapy, accelerates motor recovery, reduces hospitalization time, and improves long-term outcomes in neuromuscular diseases, including GBS (Chhetri & Hughes, 2015, p. 59; Daly et al. 2016, p. 598). In comparison, traditional rehabilitation protocols without electrotherapy often rely solely on passive techniques or voluntary effort, which may be insufficient in the presence of partial or complete denervation (Kesar & Binder-Macleod, 2015). Hence, the present study substantiates the superiority of EFS in producing faster and more uniform gains, particularly in restoring ankle function critical for gait independence.

These findings have significant implications for clinical practice, especially in low-resource settings where access to advanced rehabilitation facilities may be limited. The portability, cost-effectiveness, and simplicity of EFS devices make them ideal for

home-based or outpatient therapy programs (Gandhi et al. 2021, p. 33). Furthermore, the consistency of improvement across participants suggests a low risk of inter-individual variability, enhancing the practicality of implementing EFS in routine neuromuscular rehabilitation (Yang et al. 2016, p. 11).

Despite the encouraging results, this study is not without limitations, which must be considered when interpreting the findings. One major limitation is the relatively small sample size (n=22), which limits the statistical power and generalizability of the results to the broader GBS population (Field, 2018, p. 22). Small sample sizes increase the risk of both type I and type II errors, and although non-parametric tests were appropriately applied, larger randomized controlled trials are needed to confirm these findings (Kim et al., 2018). Additionally, the short duration of intervention and follow-up may not have captured the full extent of functional recovery or potential relapses, which are characteristic of GBS (Wakerley & Yuki, 2015, p.58). Previous studies have indicated that long-term follow-up is essential to determine sustained improvements and to monitor for potential adverse effects of prolonged stimulation (Leonhard et al. 2019, p. 39).

Another limitation involves the lack of blinding and placebo control, which may introduce performance bias, especially in rehabilitation trials where participant motivation and therapist encouragement can influence outcomes (Rea & Parker, 2015, p. 658). Although the objective outcome measures such as OGS and 10MWT help minimize subjective variability, future studies should incorporate assessor blinding and possibly sham stimulation protocols to improve internal validity (de Kroon et al. 2015, p. 639). Moreover, the study did not quantify patient adherence, stimulation intensity, or session duration in standardized metrics, which could impact the reproducibility of results across settings (Chae & Hart, 2019, p. 59).

Nevertheless, the study's strengths include its use of validated clinical tools (OGS and 10MWT), robust non-parametric analysis, and the practical application of a cost-effective intervention that has significant translational potential for clinical rehabilitation in both inpatient and community settings (Brogna et al. 2018, p. 631). Importantly, the inclusion of participants with various GBS subtypes and comorbidities improves the external validity and reflects the heterogeneous nature of clinical GBS presentations (van den Berg et al. 2014, p. 63).

The theoretical implications of this study reinforce the neuroplasticity model of rehabilitation, wherein peripheral stimulation when appropriately timed and targeted can induce central motor adaptation even in cases of demyelination or axonal degeneration (Kobayashi et al. 2023, p. 48). The results support the hypothesis that EFS not only facilitates motor unit recruitment but may also enhance cortical excitability and synaptic reorganization, thereby accelerating functional recovery (Pourmajidian et al. 2017, p. 48). This concept is particularly relevant in GBS, where lower motor neuron involvement can persist despite recovery from the acute immune-mediated phase (Wakerley & Yuki, 2015, p. 698).

In terms of future directions, it is recommended that larger-scale multicenter trials be conducted to assess the optimal stimulation parameters (frequency, amplitude, and session duration) and to evaluate long-term outcomes such as recurrence rates, fall risk, and quality of life measures (Leonhard et al. 2019, p. 60). Integration of electromyographic feedback or smart wearable sensors with EFS systems could enhance patient engagement and allow real-time monitoring of neuromuscular response, thereby tailoring interventions more precisely (Gandhi et al. 2021, p. 13). Additionally, exploring the synergistic effects of EFS combined with robotic-assisted gait training or virtual reality-based rehabilitation could unlock further avenues for augmenting neuromotor recovery (Esquenazi et al. 2020, p. 10). In conclusion, this study demonstrates that Electric Functional Stimulation applied to the tibialis anterior muscle significantly improves dorsiflexion strength and functional mobility in patients with Guillain-Barre Syndrome. The intervention produced statistically and clinically significant improvements in muscle power and walking speed, as validated by OGS and 10MWT. These results are consistent with existing literature supporting EFS as a valuable adjunct in neurorehabilitation. Although limitations such as small sample size and lack of blinding exist, the findings provide a strong foundation for further investigation into the role of neuromuscular stimulation in acute and subacute phases of GBS recovery.

LIMITATIONS

This study presents several limitations that should be considered when interpreting the results. One major limitation was the relatively small sample size, which restricts the generalizability of the findings to the wider population of patients with Guillain-Barre Syndrome (GBS). A larger sample would have provided greater statistical power and allowed for subgroup analysis. Additionally, although the involvement of an assessor helped maintain consistency in data collection, it may have introduced observer bias or subtle variability in outcome scoring. The study was conducted at a single clinical setting CRP Savar where contextual factors such as resource availability, staff experience, and treatment environment may have influenced participant outcomes, limiting external validity. Furthermore, the intervention period was relatively brief, with only 15 sessions administered over five weeks. Given the typically slow and variable recovery trajectory of GBS, this short duration may not have fully captured the potential long-term benefits of Electric Functional Stimulation (EFS). Session continuity was occasionally disrupted by public holidays or scheduling issues, which may have impacted the regularity and effectiveness of the intervention for some participants. Additionally, approximately 32% of participants were illiterate, which may have affected their ability to follow instructions or accurately report outcomes, especially in self-administered components of data collection. The study did not include long-term follow-up, which limits insight into the sustained effects of the intervention. Moreover, no neurophysiological measures such as EMG or nerve conduction studies were used to objectively assess changes in tibialis anterior activity or neural recovery, relying solely on functional outcome measures. Despite these constraints, the study provides important early evidence supporting EFS as a safe, practical, and beneficial approach for enhancing dorsiflexion and mobility in individuals with GBS. Future research should include larger samples, extended treatment durations, long-term follow-up, and combined therapy strategies to better understand the full potential and durability of EFS-based interventions.

CHAPTER-VI CONCLUSION & RECOMMENDATION

Conclusion

Electric Functional Stimulation (EFS) has emerged as a promising, evidence-based physiotherapeutic modality for neuromuscular rehabilitation. With increasing awareness among patients regarding innovative and targeted rehabilitation strategies, the application of EFS in neurorehabilitation has gained significant traction. In this study, EFS applied specifically to the tibialis anterior muscle showed positive effects on dorsiflexion, muscle strength, and gait performance in patients with Guillain-Barre Syndrome (GBS). The intervention was implemented over five weeks, with participants receiving treatment three times per week, totaling 15 sessions. Both experimental and control groups demonstrated improvements, but the group receiving EFS in addition to conventional physiotherapy exhibited significantly greater gains in muscle power and functional mobility. Improvements were particularly evident in dorsiflexion capacity, walking speed, and overall lower limb function. The intervention was well-tolerated and encouraged active patient participation, contributing to improved compliance and therapeutic outcomes. The findings highlight that targeted EFS not only accelerates recovery in affected muscles but also enhances gait mechanics, potentially reducing fall risk and improving independence. Thus, this research reinforces the effectiveness of EFS as a supplementary treatment in managing motor deficits associated with GBS and supports its integration into routine physiotherapy programs for this population.

Recommendation:

Despite the encouraging outcomes, this study had several limitations that should guide future research. The small sample size limited the generalizability of the results and prevented subgroup analysis across different GBS variants. The short duration of the intervention and the absence of follow-up assessments limited insights into the long-term sustainability of the therapeutic effects. Furthermore, the study did not incorporate objective neurophysiological tools, such as EMG or nerve conduction studies, to validate muscular and neural changes post-intervention. Future research should address these limitations by including a larger and more diverse sample, extending the duration of the intervention, and incorporating long-term follow-up to evaluate the durability of improvements. Randomized controlled trials with double-blinded designs are recommended to minimize bias and strengthen the evidence base. Additionally, integrating neurophysiological assessments would provide a more detailed understanding of the mechanisms through which EFS facilitates recovery. Researchers are also encouraged to explore the use of wearable devices and smart technology to monitor patient response and adherence in real time. Finally, comparative studies investigating the effectiveness of EFS in combination with other therapeutic modalities—such as robotic-assisted gait training or virtual reality-based therapy—would offer deeper insight into multimodal strategies for optimizing recovery in patients with GBS. These approaches will contribute to developing comprehensive, individualized, and evidence-based rehabilitation protocols aimed at maximizing functional outcomes in this population.

CHAPTER-VII REFERENCES

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Appendix – A

Institutional Review Board (IRB) Letter

SCMST-BPT/IRB/.05-23/036

To
Md Asik Ahmed Redoy
4th Year Student of B.Sc. in Physiotherapy
Session:2018-2019 , Reg No:10435
SAIC College of Medical Science & Technology (SCMST)
Mirpur-14, Dhaka-1216, Bangladesh

Subject: Approval of the thesis proposal "**: Effects of Electric Functional Stimulation on Tibialis Anterior for Dorsiflexion among the Patient with Guillain-Barre Syndrome"** by ethics committee.

Dear Md Asik Ahmed Redouy
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 evaluate the Effects of Electric Functional Stimulation on Tibialis Anterior for Dorsiflexion among the Patient with Guillain-Barre Syndrome. The study involves face-to-face interview by using semi-structured questionnaire to evaluate the effects of Electric Functional Stimulation on Tibialis Anterior for Dorsiflexion among the Patient with Guillain-Barre Syndrome 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,

03.06.24

Dr. Abul Kasem Mohammad Enamul Haque
Principal, SCMST &Chairman, Institutional Review Board (IRB)
SAIC College of Medical Science & Technology (SCMST)
Mirpur-14, Dhaka-1216, Bangladesh

Appendix –B

Application for Data Collection Permission

Permission Latter

11th Aug 2024

To

Head of Physiotherapy Department

Centre for the Rehabilitation of the Paralyzed (CRP)

Savar,Dhaka-1343

Subject: Prayer for permission to collect data from the neurology unit of CRP- Savar and CRP -Mirpur 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 (SCMST).As a part of aur course curriculum ,we have to conduct a research project for the partial fulfillment of the requirement of the degree of B.Sc in physiotherapy .My research title is **"Effects of Electric Functional Stimulation on Tibialis Anterior for Dorsiflexion Among the Patient with Guillain-Barre Syndrome"** and aim of the study is to investigate the effectiveness of EFS and usual physiotherapy interventions with dorsiflexion on tibialis anterior patient with GBS. This is a randomized control trial under the supervision of Zahid Bin Sultan ,Assistant professor of SCMST.I have chosen the neurology unit of CRP-Savar and CRP-Mirpur to collect data from the patient with Guillain-Barre Syndrome who will come to CRP for Physiotherapy treatment.

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

Yours Faithfully

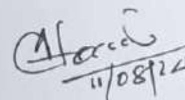
Md Asik Ahmed Redoy

B.Sc in Physiotherapy 4th Year

Session 2018-2019

SAIC College of Medical Science & Technology (SCMST)
Mirpur 14,Dhaka-1216 Bangladesh

Approved
Kindly contact with Farjana Sharmin Raman, as a coordinator of data collection process.



11/08/24

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

Appendix-C

Ethical Approval

পক্ষাঘাতগ্রস্তদের পুনর্বাসন কেন্দ্র (সিআরপি)
Centre for the Rehabilitation of the Paralysed (CRP)
a project of the Trust for the Rehabilitation of the Paralysed
Head Office: CRP Savar, Chapain, Savar, Dhaka-1343, Bangladesh
Tel: 02224445464-5, Fax: 02224445069, E-mail: contact@crp-bangladesh.org, Web: www.crp-bangladesh.org

CRP-ERC-R&E-0401-0459 15.07.2024

To

Md. Asik Ahmed Redoy

B.Sc. in Physiotherapy

Session: 2018-2019, Registration No: 10435

Saic College of Medical Science and Technology (SCMST)

asikahammed890@gmail.com

Ref: *Study Title* ''Effects of Electric Functional Stimulation on tibialis Anterior for Dorsiflexion among the Patient with Guillain-Barre Syndrome'.

Sub: Approval of documents for *Study Title* ''Effects of Electric Functional Stimulation on tibialis Anterior for Dorsiflexion among the Patient with Guillain-Barre Syndrome'.

Dear author,

The CRP Ethics Committee reviewed and discussedyour application to conduct the research entitled ''Effects of Electric Functional Stimulation on tibialis Anterior for Dorsiflexion among the Patient with Guillain-Barre Syndrome'. Which was submitted on 25th June 2024.

The following documents were reviewed:

SL. No.	Documents	Version	*Dated*	*Copy*
1	Protocol	-		1

The following members of the ethics committee reviewed the protocol on 15.06.2024.

SL. No.	**Name**	**Role in EC**	**Affiliation with Institute (Yes/No) If yes, Specify......**
1.	Prof. Dr. Mohammad Alamgir Kabir	Chair of CRPEC	No
2.	Md. Shaikhul Hasan	Member Secretary	Yes, Assist. Manager- Research, Monitoring & Evaluation.
3.	Nasirul Islam	Executive Member	Yes

CRP Mirpur, Dhaka. Mobile: 01768152922, E-mail: dgm-mirpur@crp-bangladesh.org, **CRP Ganakbari, Dhaka.** Telephone: 02 996689227, E-mail: ganakbari@crp-bangladesh.org, **CRP Manikganj**. Mobile: 01730059559, E-mail: manikganj@crp-bangladesh.org, **CRP Mymensingh - BAU Centre.** Mobile: 01730059510, E-mail: mymensingh@crp-bangladesh.org, **CRP Chattogram - A.K. Khan Centre.** Mobile: 01730059529, E-mail: chittagong@crp-bangladesh.org, **CRP Rajshahi - Afsar Hussain Centre.** Mobile: 01730059644, E-mail: rajshahi@crp-bangladesh.org, **CRP Pabna - Diabetic Shamity Centre.** Mobile: 01730059518, E-mail: pabna@crp-bangladesh.org, **CRP Barishal - CARSA Foundation Centre**. Mobile: 01730059643, E-mail: barisal@crp-bangladesh.org, **CRP Sylhet - Iskandar Shitara Centre**. Mobile: 01730059512, E-mail: sylhet@crp-bangladesh.org, **CRP Moulvibazar - Afsarul & Aktarul Haque Centre.** Mobile: 01730059628, E-mail: moulvibazar@crp-bangladesh.org, **CRP Gobindapur, Moulvibazar.** Mobile: 01730059542, E-mail: gobindapur@crp-bangladesh.org

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পক্ষাঘাতগ্রস্তদের পুনর্বাসন কেন্দ্র (সিআরপি)
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a project of the Trust for the Rehabilitation of the Paralysed
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CRP-ERC-R&E-0401-0459

15.07.24

4.	Dr. Mohammad Sohrab Hossain	Executive Member	Yes
5.	Mohammad Anwar Hossain	Executive Member	Yes, Head of Physiotherapy Department, CRP.
6.	Tauhidul Islam	Executive Member	Yes, Acting Head of Occupational Therapy Department.
7.	Tahamina Sultana	Executive Member	Yes, Head of Speech and Language Therapy Department (Acting).
7.	Md Obaidur Rahman	Executive Member	No
8.	Md. Mizanur Rahnan	Executive Member	Yes,Assist. Professor,BHPI.

We confirm that neither you nor your study team members participated in the deliberations of the Ethics Committee & did not vote on the proposal for this study.He/She promised to CRP Research department,she/he will follow every rule and regulation of CRP and research policy. This Ethical Clearance only for those who will take/collect data from CRP.

We approve the research to be conducted in its presented form at Centre for the Rehabilitation of the Paralysed (CRP).

The CRP Ethics Committee expects to be informed about the progress of the study, any Serious Adverse Effects (SAE) occurring in the course of the study, any changes in the protocol and participant's information / informed consent and asks to be provided a copy of the final report.

Please submit to the Ethical Committee (EC) the published article of the study as per EC Standard Operating Protocol (SOP)'s.

The EC is organized & operates according to the requirements of Declaration of Helsinki and ICH-GCP, local regulatory requirements and guidelines.

Yours sincerely,

Md. Shaikhul Hasan
Assistant Manager- Research, Monitoring & Evaluation,
And Member Secretary of CRP-ERC, CRP.

CRP Mirpur, Dhaka. Mobile: 01768152922, E-mail: dgm-mirpur@crp-bangladesh.org, **CRP Ganakbari, Dhaka.** Telephone: 02 996689227, E-mail: ganakbari@crp-bangladesh.org, **CRP Manikganj.** Mobile: 01730059559, E-mail: manikganj@crp-bangladesh.org, **CRP Mymensingh - BAU Centre.** Mobile: 01730059510, E-mail: mymensingh@crp-bangladesh.org, **CRP Chattogram - A.K. Khan Centre.** Mobile: 01730059529, E-mail: chittagong@crp-bangladesh.org, **CRP Rajshahi - Afsar Hussain Centre.** Mobile: 01730059644, E-mail: rajshahi@crp-bangladesh.org, **CRP Pabna - Diabetic Shamity Centre.** Mobile: 01730059518, E-mail: pabna@crp-bangladesh.org, **CRP Barishal - CARSA Foundation Centre.** Mobile: 01730059643, E-mail: barisal@crp-bangladesh.org, **CRP Sylhet - Iskandar Shitara Centre.** Mobile: 01730059512, E-mail: sylhet@crp-bangladesh.org, **CRP Moulvibazar - Afsarul & Aktarul Haque Centre.** Mobile: 01730059628, E-mail: moulvibazar@crp-bangladesh.org, **CRP Gohindapur, Moulvibazar.** Mobile: 01730059542, E-mail: gobindapur@crp-bangladesh.org

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Appendix-D

CONSENT STATEMENT (English)

Please Read It Carefully

Assalamualaikum!

I am Md Asik Ahmed Redoy, 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 " Effects of Electric Functional Stimulation on tibialis Anterior for Dorsiflexion Among the Patient with Guillain-Barre Syndrome ". In this study, I would like to find out the effect of Electric Functional Stimulation on tibialis Anterior for Dorsiflexion for Guillain-Barre Syndrome patients.

I would like to request some information regarding your sociodemographic, Disease related questions. Please note that this academic research project 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 Asik Ahmed Redoy or the research supervisor Zahid Bin Sultan Nahid Asst. professor & Head of Physiotherapy department, Saic College of Medical Science and Technology, Mirpur-14, Dhaka-1216.

Do you have any questions before I start?

☐ Yes ☐ No

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

☐ Yes ☐ No

Signature of the Participant ______________________
Date………………………

Signature of the Interviewee______________________
Date………………………

Signature of the Physiotherapist ___________________
Date………………………

Questionnaire (English)

Title: "Effects of Electric Functional Stimulation on tibialis Anterior for Dorsiflexion Among the Patient with Guillain-Barre Syndrome"

Patient Information

Patient ID:		
Date of test:		
Name of participants:		
Code:		
Address:	**Village:** **Upazila:**	**Post-Office:** **District:**
Phone:		

PART-1: Socio-Demographic Information

[Please give a tick (√) mark at the left side box of the best correct answer]

Question No	**Questions/ Information on**	**Response of the participant**
1.1	Age	…………Year
1.2	Gender	☐ 0= Male ☐ 1= Female
1.3	Marital status	☐ 0 = Unmarried ☐ 1 = Married
1.4	Educational Qualification	☐ 0 = Illiterate ☐ 1 = Primary ☐ 2 = SSC ☐ 3 = HSC ☐ 4 = Graduation ☐ 5 = Masters or higher

1.5	Occupation	☐ 0 = Service holder ☐ 1 = Businessman ☐ 2 = Housewife ☐ 3 = Student ☐ 4 = Teacher ☐ 5 = Labor ☐ 6 = Farmer ☐ 7= Other........................
1.6	Living area	☐ 0 = Rural ☐ 1 = Urban

PART-2: Anthropometric Information

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

Question No	Questions	Response of the participants
2.1	Height	……………...
2.2	Weight	……………...
2.3	BMI	………………

Part-3 :Disease Related Question

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

Question No	Questions	Response of the participants

3.1	Affected body side	☐ 0= Right ☐ 1= Left ☐ 2= Both
3.2	Type of GBS	☐ 0= AIDP ☐ 1= MFS ☐ 2= AMAN
3.3	Duration of GBS	.......................months

Part-4: Comorbidity Information

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

Question No	Questions	Response of the participants
4.1	Do you have Hypertension?	☐ 0 = No ☐ 1 = Yes
4.2	Do you have Diabetes mellitus?	☐ 0 = No ☐ 1 = Yes
4.3	Do you have congenital heart disease?	☐ 0 = No ☐ 1 = Yes

Part 5: Assessment of Muscle Strength by Muscle Strength Grading (Oxford Grade Scale):

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

Foot Dorsiflexor (Left)

Question No	Explanation	Description	Pre Grade Score	Post Grade Score
5.1	No muscle contraction felt.	Zero	☐ 0	☐ 0

5.2	Slight contraction, no visible movement.	Trace	☐ 1	☐ 1
5.3	Full range of motion in gravity-eliminated position.	Poor	☐ 2	☐ 2
5.4	Full range of motion against gravity, no resistance.	Fair	☐ 3	☐ 3
5.5	Full range of motion against gravity with moderate resistance.	Good	☐ 4	☐ 4
5.6	Full range of motion against gravity with full resistance.	Normal	☐ 5	☐ 5

Foot Dorsiflexor (Right)

Question No	Explanation	Description	Pre Grade Score	Post Grade Score
5.7	No muscle contraction felt.	Zero	☐ 0	☐ 0
5.8	Slight contraction, no visible movement.	Trace	☐ 1	☐ 1
5.9	Full range of motion in gravity-eliminated position.	Poor	☐ 2	☐ 2
5.10	Full range of motion against gravity, no resistance.	Fair	☐ 3	☐ 3
5.11	Full range of motion against gravity with moderate resistance.	Good	☐ 4	☐ 4
5.12	Full range of motion against gravity with full resistance.	Normal	☐ 5	☐ 5

Part: 06 Assessment of walking by using 10 meter walk test

a. Blood pressure:
b. Heart rate:
c. Measurement of 10-meter walk test:

10-meter walk test (m/s)	**Pre-test Score**	**Post-test Score**

অনুমতি পত্র

অংশগ্রহনকারীকে পড়ার জন্য অনুরোধ করা হইল

আসসালামু আলাইকুম!

আমি মোঃ আশিক আহমেদ হৃদয়, ঢাকা বিশ্ববিদ্যালয়ের মেডিসিন অনুষদের অধীনে সায়িক কলেজ অফ মেডিকেল সায়েন্স অ্যান্ড টেকনোলজিতে বি.এসসি. ফিজিওথেরাপির চতুর্থ বর্ষ ২০১৮-১৯ সেশনের ছাত্র। আমি "গুইলেন-বার সিন্ড্রোম আক্রান্ত রোগীদের মধ্যে ডরসিফ্লেক্সিয়নের জন্য টিবিয়ালিস অ্যান্টেরিয়র এর উপর বৈদ্যুতিক কার্যকরী উদ্দীপনার প্রভাব" শীর্ষক একটি গবেষণা কার্যক্রম পরিচালনা করছি। এই গবেষণায়, আমি গুইলেন-বার সিন্ড্রোম রোগীদের জন্য ডরসিফ্লেক্সিয়নের জন্য টিবিয়ালিস অ্যান্টেরিয়র এর উপর বৈদ্যুতিক কার্যকরী উদ্দীপনার প্রভাব জানতে চাই।

আমি আপনার সমাজ-জনসংখ্যাগত, রোগ সম্পর্কিত প্রশ্ন সম্পর্কে কিছু তথ্য অনুরোধ করতে চাই। অনুগ্রহ করে মনে রাখবেন যে এই একাডেমিক গবেষণা প্রকল্পটি সম্পন্ন হতে প্রায় ২০-৩০ মিনিট সময় লাগবে। এই গবেষণায় অংশগ্রহণ আপনার বর্তমান বা ভবিষ্যতের চিকিৎসাকে কোনওভাবেই প্রভাবিত করবে না। এটি উল্লেখ করা গুরুত্বপূর্ণ যে সংগৃহীত তথ্য শুধুমাত্র একাডেমিক গবেষণার উদ্দেশ্যে ব্যবহার করা হবে এবং আপনার প্রদত্ত সমস্ত তথ্য গোপন রাখা হবে। যেকোনো প্রতিবেদন বা প্রকাশনার ক্ষেত্রে, আমরা নিশ্চিত করব যে আপনার পরিচয় গোপন রাখা হবে।

এই গবেষণায় আপনার অংশগ্রহণ স্বেচ্ছামূলক, এবং আপনি এই গবেষণায় যেকোনো সময় কোনও নেতিবাচক পরিণতি ছাড়াই প্রত্যাহার করতে পারেন। সাক্ষাৎকারের সময় আপনার পছন্দ না হওয়া বা উত্তর দিতে না চাওয়া কোনও প্রশ্নের উত্তর না দেওয়ার অধিকারও আপনার রয়েছে।

এই গবেষণা বা অংশগ্রহণকারী হিসেবে আপনার অধিকার সম্পর্কে আপনার যদি কোনও প্রশ্ন থাকে, তাহলে অনুগ্রহ করে তদন্তকারী মোঃ আশিক আহমেদ হৃদয় অথবা গবেষণা তত্ত্বাবধায়ক জাহিদ বিন সুলতান নাহিদ সহকারী অধ্যাপক এবং ফিজিওথেরাপি বিভাগের প্রধান, সাইক কলেজ অফ মেডিকেল সায়েন্স অ্যান্ড টেকনোলজি, মিরপুর-১৪, ঢাকা-১২১৬-এর সাথে যোগাযোগ করতে দ্বিধা করবেন না।

আমি শুরু করার আগে আপনার কোন প্রশ্ন আছে?

ইন্টারভিউ নিয়ে এগিয়ে যাওয়ার জন্য আমি কি আপনার সম্মতি পেতে পারি?

অংশগ্রহণকারীর স্বাক্ষর ____________________________________
তারিখ...............................

সাক্ষাত্কারকারীর স্বাক্ষর ____________________________________
তারিখ...............................

ফিজিওথেরাপিস্টের স্বাক্ষর ____________________________________
তারিখ................................

প্রশ্নপত্র (বাংলা)

শিরোনাম: গুইলেন-বার সিন্ড্রোম আক্রান্ত রোগীদের মধ্যে ডরসিফ্লেক্সিয়নের জন্য টিবিয়ালিস অ্যান্টেরিয়র এর উপর বৈদ্যুতিক কার্যকরী উদ্দীপনার প্রভাব

রোগীর তথ্যাবলি

রোগীর আইডিঃ		
মূল্যায়নের তারিখঃ		
অংশগ্রহণকারীদের নামঃ		
কোডঃ		
ঠিকানাঃ	গ্রামঃ উপজেলাঃ	পোষ্ট অফিসঃ জেলাঃ
ফোন নাম্বারঃ		

পার্ট-১ঃ সামাজিক-জনতাত্ত্বিক তথ্য

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

ইং	প্রশ্ন	উত্তর
১.১	বয়স	…………….. বছর
১.২	লিঙ্গ	☐ ০= পুরুষ ☐ ১= মহিলা
১.৩	বৈবাহিক অবস্থা	☐ ০ = অবিবাহিত ☐ ১ = বিবাহিত

১.৪	শিক্ষাগত যোগ্যতা	☐ ০ = নিরক্ষও ☐ ১ = প্রাথমিক ☐ ২ = এসএসসি ☐ ৩ = এইচএসসি ☐ ৪ = স্নাতক ☐ ৫ = মাস্টার্স বা উচ্চতর
১.৫	পেশা	☐ ০ = সার্ভিস হোল্ডার ☐ ১ = ব্যবসায়ী ☐ ২ = গৃহিণী ☐ ৩ = ছাত্র ☐ ৪ = শিক্ষক ☐ ৫ = শ্রমিক ☐ ৬ = কৃষক ☐ ৭= অন্যান্য.................
১.৬	বাসস্থানের ধরন	☐ ০ = গ্রামীণ ☐ ১ = শহুরে

পার্ট-২: নৃতাত্ত্বিক তথ্য

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

নং	প্রশ্ন	উত্তর
২.১	উচ্চতা	....
২.২	ওজন	..................কেজি
২.৩	বিএমআই	....

পার্ট-৩ : রোগ সম্পর্কিত প্রশ্ন

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

নং	প্রশ্ন	উত্তর
৩.১	আক্রান্ত পাশ	☐ ০= ডান ☐ ১= বাম ☐ ২= উভয়
৩.২	জিবিএসের ধরণ	☐ ০= এআইডিপি ☐ ১= এম এফ এস ☐ 2= এ এম এ এন
৩.৩	জিবিএসের সময় কাল	......................মাস

পার্ট-৪: সহ-অসুস্থতার তথ্য

নং	প্রশ্ন	উত্তর
৪.১	আপনার কি উচ্চ রক্তচাপ আছে?	০ = না ১ = হ্যাঁ
৪.২	আপনার কি ডায়াবেটিস আছে?	০ = না ১ = হ্যাঁ
৪.৩	আপনার কি জন্মগত হৃদরোগ আছে?	০ = না ১ = হ্যাঁ

অংশ ৫: পেশী শক্তি গ্রেডিং (অক্সফোর্ড গ্রেড স্কেল) দ্বারা পেশী শক্তির মূল্যায়ন

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

ফুটের ডরসিফ্লেক্সিয়নের (বাম)

নং	ব্যাখ্যা	বর্ণনা	পূর্ব স্কোর	পরবর্তী স্কোর
৫.১	পেশীতে কোনো সংকোচন অনুভব হয় না।	শূন্য	☐ ০	☐ ০
৫.২	সামান্য সংকোচন অনুভব হয়, কিন্তু চোখে দেখা যায় না।	সামান্য	☐ ১	☐ ১
৫.৩	মাধ্যাকর্ষণ ছাড়া অবস্থায় পুরোপুরি নাড়াচাড়া করতে পারে।	দুর্বল	☐ ২	☐ ২
৫.৪	মাধ্যাকর্ষণের বিরুদ্ধে সম্পূর্ণ নাড়াচাড়া করতে পারে, কিন্তু কোনো প্রতিরোধ সহ্য করতে পারে না।	মাঝারি	☐ ৩	☐ ৩
৫.৫	মাধ্যাকর্ষণের বিরুদ্ধে সম্পূর্ণ নাড়াচাড়া করতে পারে, মাঝারি প্রতিরোধ সহ্য করতে পারে।	ভালো	☐ ৪	☐ ৪
৫.৬	মাধ্যাকর্ষণের বিরুদ্ধে সম্পূর্ণ নাড়াচাড়া করতে পারে, সম্পূর্ণ প্রতিরোধ সহ্য করতে পারে।	স্বাভাবিক	☐ ৫	☐ ৫

ফুটের ডরসিফ্লেক্সিয়নের (ডান)

নং	ব্যাখ্যা	বর্ণনা	পূর্ব	পরব

			স্কোর	তী স্কোর
৫.৭	পেশীতে কোনো সংকোচন অনুভব হয় না।	শূন্য	০	০
৫.৮	সামান্য সংকোচন অনুভব হয়, কিন্তু চোখে দেখা যায় না।	সামান্য	১	১
৫.৯	মাধ্যাকর্ষণ ছাড়া অবস্থায় পুরোপুরি নাড়াচাড়া করতে পারে।	দুর্বল	২	২
৫.১০	মাধ্যাকর্ষণের বিরুদ্ধে সম্পূর্ণ নাড়াচাড়া করতে পারে, কিন্তু কোনো প্রতিরোধ সহ্য করতে পারে না।	মাঝারি	৩	৩
৫.১১	মাধ্যাকর্ষণের বিরুদ্ধে সম্পূর্ণ নাড়াচাড়া করতে পারে, মাঝারি প্রতিরোধ সহ্য করতে পারে।	ভালো	৪	৪
৫.১২	মাধ্যাকর্ষণের বিরুদ্ধে সম্পূর্ণ নাড়াচাড়া করতে পারে, সম্পূর্ণ প্রতিরোধ সহ্য করতে পারে।	স্বাভাবিক	৫	৫

পার্ট: ০৬ – হাঁটার মূল্যায়ন (১০-মিটার হাঁটা পরীক্ষার মাধ্যমে)

ক. রক্তচাপ: ______________

খ. হার্ট রেট: ______________

গ. ১০-মিটার হাঁটা পরীক্ষার পরিমাপ:

	পূর্ব পরীক্ষার স্কোর	**পরবর্তী পরীক্ষার স্কোর**
১০-মিটার হাঁটা পরীক্ষা (মিটার/সেকেন্ড)		

Appendix-E

Conventional Physiotherapy Treatment

Exercise name	Dose
Positioning with postural correction	10 Reps × 1 set
Functional activity	10 Reps × 1 set
Neural connectivity exercise	10 Reps × 1 set
Active facilitatory ROM exercise	10 Reps × 1 set
Stretching for U/L and L/L-slow passive stretching	10 Reps × 1 set
Co-ordination practice- Frenkel's exercise	10 Reps × 1 set
Weight shifting and weight bearing	10 Reps × 1 set
Trunk mobilization exercise	10 Reps × 1 set
Bed mobility	10 Reps × 1 set
Strengthening program (Isometric & Isotonic)	10 Reps × 1 set
Gait re-education	10 Reps × 1 set

Proprioceptive exercise	10 Reps × 1 set
Soft tissue mobilization	10 Reps × 1 set
Parallel bar walking	10 Reps × 1 set
Transitional movement Practice	10 Reps × 1 set
Stepping	10 Reps × 1 set

Appendix-F

Experimental Group Intervention

Component	Details
Target Muscle	Tibialis Anterior
Intervention	Electric Functional Stimulation (EFS) + Conventional Physiotherapy
Elec trode Placement	Over motor point of tibialis anterior (unilateral/bilateral based on need)
Stimulation Parameters	35 Hz frequency, 300 μs pulse width, 10s on / 20s off
Session Duration	60 minutes
Frequency	3 sessions/week
Total Sessions	15 sessions (over 5 weeks)

Gant Chart

Activities/ Months	Sep 24	Oct 24	Nov 24	Dec 24	Jan 25	Feb 25	Mar 25	Apr 25	May 25	June 25	July 25	Aug 25
Proposal presentation												
Introduction												
Literature Review												
Methodology												
Data collection												
Data Analysis												
Result												
1st progress presentation												

Discussion												
Conclusion And Recommendation												
2nd progress presentation												
Communication with supervisor												
Final submission												