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"Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants at a Specialized Rehabilitation Unit"

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Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants at a Specialized Rehabilitation Unit

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DECLARATION

I am **Maruful Hasan Faruki**; I affirm that no individual component of my research project poses harm to others. All sources referenced in this study have been accurately cited. Consequently, any errors present in this project are exclusively my own, and I bear sole responsibility for any inaccuracies throughout the entirety of the study.

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List of Acronyms

Abbreviation	Elaboration
BHPI	Bangladesh Health Professions Institute
CRP	Centre for the Rehabilitation of the Paralysed
FES	Functional Electrical Stimulation
SPSS	Statistical Package for Social Sciences
SCI	Spinal Cord Injury
WISCI	Walking Index for Spinal Cord Injury
NMES	Neuromuscular Electrical Stimulation
MMT	Manual Muscle Testing

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ABSTRACT

Introduction: Spinal cord injury (SCI) constitutes a substantial portion of the worldwide injury load. In the year 2016, there were 27.04 million instances of SCI on a global scale, encompassing 0.93 million newly emergent cases. Within China, the incidence of traumatic SCI displayed an ascending trajectory spanning from 2009 to 2018, approximating 66.5 cases per one million individuals. The ramifications of SCI are profound, encompassing substantial physical, psychological, and economic encumbrances for afflicted individuals, their families, and the broader societal framework. The clinical presentations of spinal cord injury encompass conditions such as paralysis, diminished sensation, and disruptions in bladder or bowel management. Surgical interventions primarily focus on reinstating the volume of the spinal canal, achieved through the extraction of bone fragments, ligaments, and hematomas that exert pressure on the spinal cord. Despite decompressive procedures, a noteworthy proportion of patients do not exhibit amelioration in their neurological status. **Purpose:** The purpose of the study is to explore the effectiveness of functional electrical stimulation (FES) in hip extensors and knee extensors muscles in paraplegic patients. **Methodology:** This research constituted a randomized controlled trial, characterized by a single-blinded design. The study cohort comprised a total of 40 patients, selected based on predefined inclusion and exclusion criteria, and subsequently allocated into two distinct groups: a control group and an experimental group. Each group encompassed 20 patients. Across a span of four weeks, both groups underwent 20 treatment sessions. The control group received conventional physiotherapy, whereas the experimental group underwent a combination of Functional Electrical Stimulation (FES) alongside conventional physiotherapy. Assessment of all participants involved the utilization of various metrics, including the Modified Ashworth Grade Scale, Manual Muscle Test and the Walking Index for Spinal Cord Injury II (WISCI II), a metric employed for quantifying ambulatory capabilities in spinal cord injury cases. **Results:** The investigation employed the Wilcoxon Rank Test and the Kruskal- Wallis test to analyze the outcomes. The average age of participants in the experimental group was determined to be 28.85, while the control group exhibited an average age of 32.95. Notably, there was a statistically significant improvement in the tone of the lower limb,

as assessed by the Ashworth Grade Scale, with a significance level below 0.05. Additionally, the enhancement in muscle power, evaluated through manual muscle testing, was found to be statistically significant, with a p-value below 0.05. The assessment of ambulatory function, conducted using the WISCI II scale, also yielded statistically significant results, with a p-value below 0.05. **Conclusion:** This study is conducted to find out the effectiveness of FES, along with conventional therapy. Effectiveness is shown without any contradiction. Further research should be conducted with both male and female participants in large population.

Keywords: *Mannual muscle testing, ashworth grade scale, WISCI II scale, tone, ambulation.*

CHAPTER-1 INTRODUCTION

1.1 Background

In the realm of lifetime care planning and case management, the formulation of prospective service models stands as a pivotal consideration. The strategic targeting of health promotion and prevention interventions, coupled with the precise anticipation of life expectancy, assumes paramount importance in this domain. Researchers, spanning the past half-century, have diligently scrutinized survival rates after spinal cord injury (SCI), elucidating key determinants that significantly influence outcomes. In this comprehensive exploration, gender, age at the time of injury, neurological level, degree of impairment, ventilator dependency, etiological factors, the temporal decade of injury occurrence, and the interval between injury and life expectancy estimation emerge as critical predictors. The discernment of these multifaceted elements not only contributes to an accurate prognostication of life expectancy but also aids in crafting nuanced and targeted interventions for health promotion and prevention. This intricate understanding of factors influencing mortality following SCI lays a robust foundation for informed and effective lifetime care planning and case management strategies (Middleton et al. 2012).

A spinal cord injury (SCI) is a complex and often devastating medical condition that occurs when there is damage to the spinal cord, disrupting its normal function. The spinal cord, a crucial component of the central nervous system, is responsible for transmitting signals between the brain and the rest of the body. Injuries to the spinal cord can result in a range of impairments, affecting motor, sensory, and autonomic functions. The causes of spinal cord injuries are diverse and can include traumatic events such as car accidents, falls, sports injuries, or violence. Non-traumatic causes, like infections, tumors, or degenerative conditions, can also lead to spinal cord damage. The severity of an SCI depends on the location and extent of the injury, with consequences varying from temporary dysfunction to permanent disability. Common manifestations of spinal cord injuries include paralysis, loss of sensation, and changes in bodily functions. Paralysis may be classified as quadriplegia, affecting both arms and legs or paraplegia, which impacts the lower half of the body. The level of injury on the spinal cord determines which body parts are affected (Mcdonald and Sadowsky 2002).

The designation "spinal cord injury" pertains to the impairment inflicted upon the spinal cord, arising from various causative factors such as trauma, illness, or degenerative conditions. The precision of global prevalence figures remains elusive, yet estimations posit an annual incidence rate ranging from 40 to 80 cases per one million individuals. Notably, within this statistical landscape, traumatic events emerge as the predominant instigators, contributing to up to 90% of reported cases. However, a discernible trend unfolds, signifying a gradual escalation in the prevalence of non-traumatic spinal cord injuries over the temporal continuum. This evolving pattern suggests a noteworthy shift in the etiological composition of spinal cord injuries, indicating a complex interplay of factors that extend beyond traumatic incidents. As such, a comprehensive understanding of the evolving epidemiological dynamics surrounding spinal cord injuries is imperative for informed healthcare strategies and resource allocation (WHO 2013).

Spinal cord injury (SCI) constitutes a significant proportion of the global injury burden, with a reported 27.04 million cases worldwide in 2016 (confidence interval: 24.98-30.15 million), including 0.93 million new cases (confidence interval: 0.78-1.16 million). Within the timeframe spanning 2009 to 2018, South Asia recorded an estimated 66.5 incidences of trauma-related SCI per million people. Beyond the stark numerical representation, SCI exacts a profound toll, inflicting severe physical, psychological, and financial burdens upon those directly affected, their families, and society as a whole. The intricate interplay of these dimensions underscores the complexity of SCI's impact, necessitating a comprehensive approach to address not only the immediate medical ramifications but also the broader socio-economic and emotional implications. Recognizing and navigating these multifaceted challenges is pivotal for the formulation of targeted interventions and policies aimed at alleviating the burdens imposed by SCI on individuals and society (Xu et al. 2022).

Emerging evidence suggests that neuroplastic changes can occur years after a spinal cord injury, resulting in diminished disability and improved overall health, potentially leading to reduced healthcare costs. Specifically, in cases of motor-incomplete spinal cord injury, the recovery of leg function is possible through repetitive training, generating afferent input to the lumbar spinal cord. While activity-based therapy

without electrical stimulation can induce this afferent input, our findings demonstrate that the process is expedited when electrical stimulation is employed. This stimulation may take the form of either spinal cord stimulation or peripheral nerve stimulation.

Our research indicates that the pace of recovery is accelerated when the stimulation is phasic and when patients actively attempt to utilize their legs during training sessions. It is important to note that existing published studies are limited in size, warranting cautious interpretation of conclusions. However, preliminary findings suggest that individuals with greater disability (AIS A and B) might benefit from ongoing stimulation, with an implanted stimulator offering convenience.

Conversely, individuals with lesser disability (AIS C and D) may experience meaningful recovery and an enhanced quality of life through a targeted therapy regimen. We propose that cycling with electrical stimulation, utilizing biofeedback to encourage descending drive, could facilitate rapid recovery. Importantly, this form of therapy could be employed with minimal supervision at home, presenting a more cost-effective option. Combining electrical therapy with subsequent conventional physiotherapy could potentially be a financially viable and accessible solution for a substantial number of individuals living with chronic spinal cord injuries (Duffell and Donaldson 2020)

Spinal cord injury (SCI) has emerged as a significant traumatic condition, witnessing an alarming surge in morbidity and fatality rates in recent years. Diverse factors, such as trauma, infection, inflammation, or tumors, contribute to the occurrence of spinal cord injuries. The consequence of these factors often manifests in the compression of the spinal cord, precipitating a potential loss of motor and sensory function below the affected level, either temporarily or permanently. Within the medical lexicon, an injury below the cervical region is denoted as paraplegia. This condition underscores the complexity of spinal cord injuries, emphasizing the need for a comprehensive understanding of their diverse etiologies and the profound impact they have on neurological functions. The evolving landscape of SCI morbidity and fatality rates underscores the imperative of continuous research and innovative approaches for

prevention and treatment strategies to mitigate the consequences of this challenging medical condition (Pang et al. 2023).

Paraplegia arises when a particular condition or injury affects the segment of the nervous system that governs the lower body. Indicative symptoms encompass difficulties in flexing muscles within the abdominal area, feet, and legs. It is noteworthy that paraplegia may, at times, exclusively impact one leg, a scenario termed as partial paraplegia. This nuanced classification reflects the variable nature of this condition, acknowledging instances where motor and sensory impairment is incomplete and highlighting the diversity in its clinical manifestations. Understanding these subtleties is crucial for tailored medical assessments and interventions in the realm of paraplegia (Elsevier 2009).

Functional electrical stimulation (FES), a technology enabling intentional contractions of muscles affected by paralysis, has been employed by individuals with spinal cord injury (SCI) since the 1980s to facilitate various functional activities. The sustained application of FES over time has demonstrated the potential to enhance not only functional mobility but also to yield therapeutic benefits. These advantages encompass the mitigation of muscle spasms, augmentation of blood circulation in stimulated regions, and enhancement of muscle strength in those muscles rendered paralyzed. This underscores the enduring utility and multifaceted positive effects associated with the chronic utilization of FES in the context of spinal cord injury rehabilitation (Nightingale et al. 2007).

Functional Electrical Stimulation (FES) is a device that employs electrical impulses to induce muscle contractions. This mechanism is implemented through electrodes affixed to the skin, generating electrical impulses that mimic the action potentials of the central nervous system. By orchestrating synchronous contractions, FES ensures the simultaneous stimulation of all motor units. This technology is harnessed for strength training, leveraging its capacity to elicit both neurological and muscular responses. Its application is instrumental in preventing muscular atrophy resulting from muscle inactivity subsequent to musculoskeletal injury. In essence, FES serves as a valuable tool to mitigate the deleterious effects of immobility on muscle health post-injury (Sharif 2017).

Electrical stimulation serves a tripartite purpose: aiding in diagnostics, functioning as a therapeutic instrument, and contributing to the recovery of impaired or lost functions. The application of Functional Electrical Stimulation (FES) can be categorized into three distinct classes based on the functions it facilitates: the reinstatement of sensory functions, the revival of skeleto-motor functions, and the restoration of autonomic functions. FES, employing artificial electrical stimulation, specifically targets muscles in limbs deprived of neurological control due to injury. Its objective is to induce controlled movements that prove beneficial in daily activities, thereby offering a rehabilitative approach to enhance functional abilities in individuals facing neurological challenges (Bhatia et al. 2011).

Over the last three decades, Functional Electrical Stimulation (FES) has been instrumental in reinstating walking abilities for individuals with paraplegia. FES systems deploy an intricate arrangement of electrodes, positioned either within the body or on its surface, to convey sequences of electrical pulses. These pulses are meticulously timed to coordinate the actions of paralyzed muscles. The outcome is a purposeful contraction of the targeted muscles, consequently generating stepping movements. In essence, FES serves as a sophisticated technology that orchestrates coordinated muscle activity through the application of controlled electrical impulses, facilitating the restoration of walking capabilities in those affected by paraplegia. (Kobetic et al. 2007).

1.2 Rationale

The challenges faced by paraplegic patients in Bangladesh are exacerbated by a dearth of knowledge and resources. While the global community has been utilizing Functional Electrical Stimulation (FES) since the 1980s, this technology remains inaccessible within our nation's borders. FES, known for its user-friendly interface and its capacity to enhance motor functionality, also presents an opportunity to mitigate muscle spasms in cases of incomplete injuries. The objective of this research endeavor is to assess the efficacy of FES in improving knee flexor function and to foster awareness regarding the utilization of this innovative device. Bangladesh, classified as a developing third-world nation, grapples with significant challenges in multiple sectors. One particularly concerning aspect is the state of education, which remains notably inadequate. Furthermore, both governmental and non-governmental health initiatives have struggled to make substantial inroads in addressing the healthcare needs of the local population. In the context of healthcare, it's noteworthy that physiotherapy is not an entirely nascent profession in Bangladesh. However, due to a shortage of skilled professionals, it remains a relatively young health discipline, often overshadowed by other healthcare sectors. Functional Electrical Stimulation (FES), a modern technological advancement in healthcare, has yet to gain widespread recognition and acceptance within the Bangladeshi context. In an era where therapeutic devices play a pivotal role in patient care globally, there is a pressing need to promote awareness about electrotherapy and its potential benefits. Compounding this issue is the unfortunate reality that the number of individuals affected by health conditions amenable to electrotherapy is steadily increasing in Bangladesh. This surge in health-related challenges has far-reaching consequences, negatively impacting not only the affected individuals but also their families, the broader society, and the nation as a whole. It underscores the urgency of addressing these issues and harnessing modern therapeutic technologies to improve healthcare outcomes in the country. Proper rehabilitation is of utmost importance because it is a dangerous disorder that can have high morbidity and mortality. This study will be useful to physiotherapy professionals in learning more about the modern treatment of spinal cord injuries in Bangladesh. Other medical professionals will gain updated information regarding the factors contributing to spinal cord damage. In order Creating a more effective rehabilitation program, will also be helpful for paraplegic participants.

1.3 Operational Definition

Spinal Cord Injury (SCI): A spinal cord injury (SCI) refers to damage to the spinal cord that results in a loss or impairment of normal motor, sensory, or autonomic function. The spinal cord is a crucial part of the central nervous system, extending from the base of the brain down the back. It is responsible for transmitting nerve signals between the brain and the rest of the body, allowing for voluntary and involuntary movements, as well as the perception of sensations. Spinal cord injuries can occur due to trauma, such as a sudden blow or impact to the spine, or non-traumatic causes like infections, tumors, or degenerative diseases.

Paraplegia: Paraplegia is a condition characterized by the impairment or loss of motor and sensory function in the lower half of the body. It typically results from damage to the spinal cord, often due to injury or disease. People with paraplegia experience paralysis of the lower extremities, including the legs and sometimes the lower trunk. The level and extent of paraplegia depend on the location and severity of the spinal cord injury. If the injury occurs in the thoracic (upper back) or lumbar (lower back) regions of the spinal cord, it can lead to paraplegia.

Functional Electrical Stimulation (FES): It is a therapeutic technique that uses electrical currents to stimulate nerves and muscles, producing contractions in paralyzed or weakened muscles. The primary goal of FES is to improve or restore functions such as muscle strength, motor control, and mobility in individuals with neurological disorders or conditions that affect the normal functioning of muscles.

Knee Extensors: Knee extensors are a group of muscles responsible for straightening or extending the knee joint. The primary knee extensor muscles are located at the front of the thigh (anterior compartment) and are collectively known as the quadriceps femoris. The quadriceps femoris is a group of four muscles:

1. **Rectus Femoris:** This is the only quadriceps muscle that crosses both the hip and knee joints. It originates from the anterior inferior iliac spine and inserts into the patella and tibial tuberosity.

2. **Vastus Lateralis:** This muscle is on the outer side of the thigh. It originates from the greater trochanter and the linea aspera of the femur and inserts into the patella and tibial tuberosity.
3. **Vastus Medialis:** Positioned on the inner side of the thigh, it originates from the linea aspera and inserts into the patella and tibial tuberosity.
4. **Vastus Intermedius:** This muscle lies deep to the rectus femoris and is situated between the vastus lateralis and vastus medialis. It also inserts into the patella and tibial tuberosity.

Hip Extensors: Hip extensors are a group of muscles responsible for extending the hip joint, moving the thigh backward. The primary hip extensor muscles are located in the posterior (back) aspect of the hip and thigh. The major hip extensor muscles include:

1. **Gluteus Maximus:** This is the largest muscle in the buttocks and is a powerful hip extensor. It originates from the ilium, sacrum, and coccyx and inserts into the femur. The gluteus maximus is involved in activities such as standing up from a seated position, climbing stairs, and running.
2. **Hamstring Muscles (Semimembranosus, Semitendinosus, Biceps Femoris):** While the primary function of the hamstrings is knee flexion, they also play a role in hip extension. These muscles originate from the ischial tuberosity (except for the short head of the biceps femoris, which originates from the femur) and insert into the tibia and fibula. The long head of the biceps femoris crosses both the hip and knee joints.
3. **Adductor Magnus:** This muscle is primarily an adductor (brings the thigh toward the midline of the body), but its posterior fibers also contribute to hip extension. It originates from the ischial tuberosity and inserts into the femur and the linea aspera.

Effectiveness: Effectiveness refers to the degree to which something is successful in producing the desired results or outcomes. It is a measure of how well a particular method, strategy, process, or intervention achieves its intended purpose or goals. In various contexts, effectiveness is often associated with the efficiency and success of an action in bringing about positive and meaningful results.

1.4 Aim

To evaluate the Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants at a Specialized Rehabilitation Unit**.**

1.5 Objectives

1.5.1General Objectives

To find out the Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants.

1.5.2 Specific Objectives

1. To find out the socio-demographic status and medical information of participants.
2. To measure the effectiveness of Functional Electrical Stimulation (FES) in the improvement of tone in participants with paraplegia.
3. To find out the effectiveness of Functional Electrical Stimulation (FES) along with conventional physiotherapy to measure improvement in walking ability of paraplegic participants.
4. To find out the effectiveness of Functional Electrical Stimulation (FES) along with conventional physiotherapy to measure improvement in muscle Power improvement of paraplegic participants.

1.6 Hypothesis

Null hypothesis ((H0)

Functional Electrical Stimulation (FES) and conventional physiotherapy are no more effective than conventional therapy for treating patients with paraplegia.

Ho: μ1-μ2 =0 or μ1=μ2, where the experimental group and control group initial and final mean difference is same.

Alternative hypothesis

Functional Electrical Stimulation (FES) along with conventional physiotherapy is more effective than only conventional therapy for the treatment of patients with stroke.

Ha: μ1-μ2 ≠ or μ1 ≠ μ2, where the experimental group and control group initial and final mean difference is not same.

CHAPTER: II LITERATURE REVIEW

One salient discovery from this study pertains to the enhancement of life expectancy among individuals with spinal cord injuries (SCI) over the comprehensive 50-year examination period. This observed improvement is attributed to advancements in healthcare delivery, progressive rehabilitation practices, and the incorporation of assistive technologies into SCI patient care. Additionally, a noteworthy distinction is drawn within the study between traumatic and non-traumatic SCI cases. Notably, traumatic SCI cases tend to manifest more favorable life expectancy outcomes. This differentiation is of considerable significance as it sheds light on the distinct effects of injury types on life expectancy within the SCI population, offering valuable insights into the varying trajectories of this medical condition. Furthermore, the study discerns age and gender as prominent determinants exerting substantial influence on life expectancy following an SCI. Specifically, the findings emphasize that younger individuals and females, as a demographic group, generally manifest extended life expectancies within the context of spinal cord injuries. This demographic variation underscores the pivotal role that age and gender dynamics play in shaping the long-term outlook for individuals grappling with SCI (Nightingale et al. 2007).

The article furnishes readers with an extensive historical narrative, unveiling the trajectory of Functional Electrical Stimulation (FES) from its inception to its contemporary state. This historical contextualization affords readers a profound understanding of the evolutionary journey encompassing the technology and its diverse applications. The article further delves into a comprehensive exposition on the various manifestations of FES, distinguishing between surface and implanted modalities. Within this exploration, it provides detailed insights into the specific clinical contexts and scenarios where each form of FES finds its application. Moreover, the article thoroughly investigates the intricacies of control strategies and stimulation parameters associated with FES. These elements are identified as pivotal factors that wield substantial influence in the refinement and optimization of FES interventions, adding to the precision and efficacy of the treatment. Furthermore, the article undertakes a meticulous review of clinical outcomes and the effectiveness of FES across a spectrum

of applications. Through this scrutiny, it endeavors to offer illuminating perspectives on the potential advantages and therapeutic benefits that FES can bestow upon patients within various medical domains (Bhatia et al. 2011).

The principal aim of this study is to systematically assess the therapeutic effectiveness of Functional Electrical Stimulation (FES) in the context of ameliorating grasping capabilities in individuals afflicted by traumatic incomplete spinal cord injuries (SCI). The study's primary focus revolves around scrutinizing the functional ramifications and prospective advantages associated with the implementation of FES interventions.This research endeavors to substantiate that FES therapy engenders noteworthy enhancements in the proficiency of grasping tasks among individuals beset by traumatic incomplete SCI. The research outcomes prominently underscore FES as a potent modality with the capacity to augment upper extremity motor functionality in this patient demographic. Moreover, this investigation underscores the profound clinical significance inherent in the realm of FES therapy by elucidating its remarkable potential to exert favorable influences on fundamental facets of daily life and functional self-sufficiency. It illustrates how FES can be a pivotal contributor to enhanced autonomy and quality of life for individuals grappling with the consequences of spinal cord injuries (Kapadia et al. 2017).

The principal aim of this study is to conduct a thorough inquiry into the advantages associated with the application of Functional Electrical Stimulation (FES) within the realm of gait rehabilitation, particularly for individuals afflicted by spinal cord injuries (SCI). The research endeavors to assess the favorable outcomes and prospective merits intrinsic to the utilization of FES technology in the context of enhancing functions relevant to walking. This investigation substantiates that the incorporation of FES into gait training yields remarkable enhancements in the domain of gait function for individuals who have sustained spinal cord injuries. These enhancements encompass pivotal elements such as augmented walking speed, extended stride length, and an overall heightened level of mobility. Furthermore, the research illuminates the considerable potential inherent in FES to augment the quality of life experienced by individuals grappling with the consequences of spinal cord injuries. This is achieved by enabling greater self-reliance and mobility in the performance of routine daily activities. To bolster the scientific rigor of the study, a noteworthy feature entails the

meticulous utilization of objective measures and assessments to scrutinize the effects of FES on a spectrum of gait parameters. This approach not only enhances the credibility of the research but also substantiates the tangible impacts of FES in the context of gait rehabilitation (Nightingale et al. 2007).

The primary objective of this research is to determine whether Functional Electrical Stimulation (FES) exhibits superior effectiveness or parity with conventional electrical stimulation concerning the enhancement of gait function in individuals who have suffered a stroke. The study is anticipated to encompass a comprehensive assessment of a spectrum of gait parameters, including but not limited to walking speed, stride length, balance, and overall mobility. These evaluations are designed to provide a comprehensive understanding of the impact of both FES and conventional electrical stimulation on gait. The findings of this investigation are poised to yield consequential implications of a practical nature for healthcare providers and clinicians. They stand to offer valuable insights that can inform and guide the decision-making process regarding the selection of appropriate gait rehabilitation interventions for individuals recovering from stroke. Given that gait impairment is a prevalent and clinically substantial consequence of stroke, the study's emphasis on this facet of rehabilitation aligns with the imperative to address a critical clinical concern. Furthermore, the research design, which systematically juxtaposes FES against conventional electrical stimulation, contributes significantly to advancing our comprehension of the relative efficacy of these two modalities in the realm of gait rehabilitation. This methodological approach holds promise in shedding light on their comparative merits and, in turn, facilitating more informed clinical choices for the benefit of stroke patients (Nightingale et al. 2007).

This research's primary aim revolves around an exhaustive exploration of the pivotal role that muscle selection plays in the domain of ambulation utilizing multichannel Functional Electrical Stimulation (FES) systems among individuals diagnosed with paraplegia. The comprehensive scope of this study encompasses a profound comprehension of how the judicious selection of specific muscles as targets for FES stimulation significantly impacts the overall quality and efficacy of walking performance within this distinct demographic.

The core thrust of this research is to meticulously discern and delineate optimal strategies for muscle selection in the context of FES-induced ambulation. This rigorous inquiry seeks to delineate, with precision, the muscle groups that wield the utmost effectiveness in facilitating ambulation for individuals grappling with the challenges of paraplegia.

Moreover, this study is anticipated to engage in a multifaceted assessment, encompassing various facets of walking performance. This holistic evaluation spans essential parameters including walking velocity, stability during ambulation, and the endurance exhibited during protracted walking endeavors. Through this comprehensive evaluation, the research aspires to critically assess and juxtapose the efficacy of diverse approaches to muscle selection when coupled with multichannel FES systems.

In a broader context, the insights derived from this research are poised to have profound clinical ramifications. They have the potential to significantly inform the conceptualization, design, and execution of FES-based ambulation interventions for individuals confronting the challenges of paraplegia. This empirical foundation can potentially chart a course for the evolution of future rehabilitation strategies, thereby contributing to an enhanced quality of life and increased mobility for this specific patient cohort.

Importantly, this study addresses a pressing clinical concern, as it delves into the nuanced aspects of muscle selection within the realm of FES systems—an area of paramount importance for enhancing the mobility and overall well-being of individuals grappling with paraplegia. Moreover, the adoption of objective measures such as gait analysis and electromyography (EMG) imparts a robust scientific rigor to the research, bolstering its credibility and significance in the field of neurorehabilitation (Kapadia et al. 2011).

The study, conducted by Davoodi and Andrews in 2004, examined the feasibility and effectiveness of incorporating fuzzy logic control into the optimization of Functional Electrical Stimulation (FES) during rowing exercises for individuals with paraplegia. This research approach was designed to fine-tune stimulation parameters in response to real-time feedback.

The research likely elucidated how the integration of fuzzy logic control augmented exercise performance for participants with paraplegia, encompassing various facets such as rowing efficiency, muscle engagement, and the overall quality of the exercise experience.

The study's findings held substantial implications for the field of assistive technology and rehabilitation, particularly for individuals with paraplegia. Through the application of fuzzy logic control, the research contributed to the evolution of more adaptive and responsive FES systems, tailored to the distinct needs and capabilities of each participant.

This study, addressing a critical clinical need in the realm of exercise and mobility enhancement for individuals with paraplegia, potentially advanced their overall quality of life. However, a comprehensive understanding of the research's strengths and limitations necessitates access to the full article, including specific details regarding methodology and results (Davodi 2011).

The study delved comprehensively into the utilization of Functional Electrical Stimulation (FES) as an integral component of neuroprocessing, a pivotal strategy that empowered individuals afflicted by spinal cord injury (SCI) to regain control and functionality across diverse body systems. This encompassed the restoration of upper limb function, grasp capabilities, and bladder control, representing a remarkable advancement in enhancing the quality of life for individuals living with SCI.

Moreover, the research meticulously examined FES in its role as a facilitator of muscle stimulation. This entailed its application in the prevention of muscle atrophy, the augmentation of muscle strength, and the promotion of physical fitness among individuals grappling with SCI. Such an approach heralded significant progress in mitigating the physical challenges associated with SCI.

The article, in its comprehensive exploration, shed light on how FES played an instrumental role in effecting functional improvements in patients afflicted by SCI. The emphasis was placed on its capacity to restore mobility, enable ambulation, and facilitate the execution of activities of daily living, thereby elevating the overall independence and quality of life for affected individuals.

Furthermore, it is plausible that the study addressed the applications of FES in addressing the intricate challenges of bladder and bowel dysfunction following SCI. This facet of the research was pivotal, as it constituted an indispensable component of the rehabilitation process, significantly contributing to the overall well-being and quality of life of individuals grappling with the consequences of SCI. (Kapadia et al., 2011).

The study endeavors to investigate the utilization of Neuromuscular Electrical Stimulation (NMES) as an intervention with therapeutic implications. This encompasses the deliberate and regulated application of electrical stimulation to the muscles in paralyzed hindlimbs, with a particular emphasis on the sustained and persistent nature of this stimulation.

The research is poised to conduct an evaluation of the functional consequences associated with the enduring application of NMES. This assessment includes an exploration of enhancements in parameters such as muscle strength, endurance, and coordination within the context of hindlimbs rendered immobile by paralysis. Furthermore, the research may delve into the potential for neural plasticity and the prospects for reinstating motor function.

To execute this investigation effectively, a rodent model is employed as a surrogate, allowing for meticulously controlled experiments and observations. This choice of model facilitates the acquisition of valuable insights into the fundamental mechanisms underlying the effects of chronic NMES.

In its essence, this research is intrinsically tied to a clinically pertinent concern, namely, the domain of neuromuscular rehabilitation and the prospect of achieving functional recovery in limbs afflicted by paralysis. It embodies a pursuit of knowledge with the potential to advance therapeutic strategies and interventions, offering hope to individuals grappling with conditions that compromise their motor function and mobility (Jung et al. 2009).

Over the course of over four decades of research in Functional Electrical Stimulation (FES), fundamental guidelines for the secure stimulation of neuromuscular tissue have

been established, and techniques for regulating the intensity of muscle contractions induced by electrical means have been uncovered (Bhatia et al. 2011).

Functional Electrical Stimulation (FES) enables individuals to employ their limbs in manners that would be unattainable through their own voluntary efforts during the initial phases of recovery. Consequently, this promotes early autonomy and serves as a source of motivation for rehabilitation (Kapadia et al. 2011).

CHAPTER: III METHODOLOGY

This study was a randomized control trial designed to find out the Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants at a Specialized Rehabilitation Unit To identify the effectiveness of treatment regime, Modified Ashworth Grade Scale, Manual Muscle Testing, Walking Index for Spinal Cord Injury II (WISCI II) were used as a measurement tool for measuring lower limb function caused by stroke. All patients signed an informed consent form before their inclusion into the study.

3.1 Study design

The study was conducted using a quantitative randomized control trial design with two different subject groups. Randomized control; trial design method of testing hypothesis by which cause and effect can be established.

The study was true experimental between different subject designs. Both groups received a common treatment regimen. In this experiment group received FES alone with conventional physiotherapy and the control group received the conventional physiotherapy only.

A pre-test and post-test were administrated with each subject of both groups to compare the pain effects, and functional ability before and after the treatment.

3.2 Study Site:

The study area was Spinal Cord Injury unit of Physiotherapy department of Centre for the Rehabilitation of the Paralysed (CRP), Savar, Dhaka.

3.3 Study Population

The study population was the patients diagnosed as paraplegic SCI in the SCI Unit of the Physiotherapy Department.

3.4 Duration of Data collection: June 2023 to August 2023

3.5 Sample Size

Approximate value of efficacy/cure rate for standard treatment (e.g., 60%) = P1

Approximate value of efficacy/cure rate for new drug (e.g., 70%) = P2

Effect size (i.e., difference in efficacy of control and experimental group, e.g., 20%) = (P2-P1)

Level of significance (usually 5%)

How high should the probability of obtaining

significant result be (“power,” e.g., 90%)

Here, P1 = 0.6, P2= 0.7

P = (0.6 + 0.8)/2=0.7

$\alpha = 0.10$, $\beta = 0.20$

$$n = \frac{[Z_{1-\alpha/2}\sqrt{2P(1-P)} + Z_{1-\beta}.\sqrt{\{P_1(1-P_1) + P_2(1-P_2)\}}]^2}{(P_1-P_2)^2}$$

where $P=(P_1+P_2)/2$

n = 327

Lack of time and study area were not large enough and lack of diagnostic tools and there was not enough clinical physiotherapist the researcher did not take this sample and chosen the 40 patients for this research.

In this study, 40 participants were selected according to inclusion and exclusion criteria. 20participants were in the experimental group and 20 participants in control group.

3.6 Sampling

The study employed the Simple Random Sample Technique, wherein individuals meeting the predetermined inclusion criteria were selected as the study sample. A total of 40 patients were chosen from the Spinal Cord unit of the physiotherapy department at CRP, Savar. Subsequently, 20 patients were allocated to the Experimental group for the application of FES therapy in conjunction with conventional physiotherapy, while the remaining 20 were assigned to the Control group, receiving conventional physiotherapy alone. The assignment process was executed through computer-generated random numbers utilizing Microsoft Office Excel 2019, a practice adopted to enhance the internal validity of experimental research. Numeric identifiers, namely C1, C2, C3, etc., were assigned to the Control group participants, while E1, E2, E3, etc., were assigned to the Experimental group. The study employed a single-blinded technique to maintain scientific rigor.

3.7 Inclusion criteria

- Patients had a diagnosis of spinal cord injury with Paraplegia.
- Paralysis of the lower limb.
- Age limit more than 18 years.
- No orthopedic deficits.
- Patients can provide informed consent.

3.8 Exclusion criteria

- Patients considered unable to participate in this study because of psychiatric problems.
- Unconscious patients.
- Patient having contractures in the lower limb.
- Hemiplegic patient with cognitive and perceptual disorders.

3.9 Data Collection Procedure

The procedural framework of the study encompassed a sequential examination involving patient assessment, initial recording, treatment administration, and final recording. Following patient screening within the department, a qualified physiotherapist conducted assessments. Each subject underwent a standardized 20-session treatment regimen. Selection of the forty participants adhered to predefined inclusion criteria, with subsequent categorization into two groups: the control group, denoted as C1 (20 participants), and the experimental group, denoted as E1 (20 participants). The experimental group received conventional physiotherapy with scapular stabilization exercises, while the control group received solely conventional physiotherapy.

Data collection transpired through a systematic process involving randomization, pretesting, intervention, and post-testing. A meticulously prepared written questionnaire, developed by the researcher under the supervisor's guidance, facilitated data collection. The questionnaire incorporated the Ashworth Grade Scale for lower

limb tone assessment, manual muscle testing to quantify muscular activity improvement, and the Walking Index for Spinal Cord Injury II (WISCI II) for ambulation assessment. Pretesting occurred prior to intervention, and identical procedures were repeated for post-test data collection. To mitigate bias, data collection in both experimental and control groups transpired in the presence of a qualified physiotherapist. Subsequent to the study, a specific statistical analysis was conducted to interpret the findings.

3.10 Data Collection Tool

In the context of this specific investigation, data collection employed a written questionnaire, alongside traditional tools such as pen and paper. Additionally, the Ashworth Grade Scale, Manual Muscle Testing, and the Walking Index for Spinal Cord Injury II (WISCI II) were utilized as instrumental measures for the acquisition of data.

3.11 Questionnaire:

The survey instrument employed in this study was meticulously developed under the vigilant oversight, guidance, and approval of the supervisor, in strict adherence to established guidelines. The questionnaire adopted a structured format with closed-ended queries, integrating the Ashworth Grade Scale for the systematic evaluation of lower limb tone, manual muscle testing to quantify enhancements in muscular activity, and the WISCI II scale for the comprehensive assessment of ambulation. The formulated inquiries were designed to elucidate the efficacy of Functional Electrical Stimulation (FES) in the context of individuals with paraplegia.

3.12 Measurement tools:

3.12.1 Ashworth Grade Scale

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

3.12.2 Manual Muscle Testing (MMT)

0	No palpable contraction
1	Visible or palpable contraction but unable to move
1+	Able to move through a small range (<50%) with gravity eliminated
2-	Able to move through a large range (= or > 50%) with gravity eliminated
2	Able to move through full range (= 100%) with gravity eliminated
2+	Able to move through a small range (<50%) against gravity
3-	Able to move through a large range (= or > 50%) against gravity
3	Able to move through full range (= 100%) against gravity
3+	Able to move through full range (= 100%) against gravity with small resistance through a small range (<50%)
4-	Able to move through full range (= 100%) against gravity with small resistance through full range (= 100%)
4	Able to move through full range (= 100%) against gravity with moderate resistance through full range (= 100%)
4+	Able to move through full range (= 100%) against gravity with maximal resistance through range (< 100%)
5	Normal strength

3.12.3 Scoring Sheet for the Walking Index for Spinal Cord Injury II (WISCI II)

Level	Description
0	Client is unable to stand and/or participate in assisted walking.
1	Ambulates in parallel bars, with braces and physical assistance of two persons, less than 10 meters
2	Ambulates in parallel bars, with braces and physical assistance of two persons, 10 meters.
3	Ambulates in parallel bars, with braces and physical assistance of one person, 10 meters.
4	Ambulates in parallel bars, no braces and physical assistance of one person, 10 meters
5	Ambulates in parallel bars, with no braces and no physical assistance, 10 meters.
6	Ambulates with walker, with braces and physical assistance of one person, 10 meters.
7	Ambulates with two crutches, with braces and physical assistance of one person, 10 meters.
8	Ambulates with walker, no braces and physical assistance of one person, 10 meters.
9	Ambulates with walker, with braces and no physical assistance, 10 meters.
10	Ambulates with one cane/crutch, with braces and physical assistance of one person, 10 meters.
11	Ambulates with two crutches, no braces and physical assistance of one person, 10 meters.
12	Ambulates with two crutches, with braces and no physical assistance, 10 meters.
13	Ambulates with walker, no braces and no physical assistance, 10 meters.
14	Ambulates with one cane/crutch, no braces and physical assistance of one person, 10 meters.
15	Ambulates with one cane/crutch, with braces and no physical assistance, 10 meters.

16 Ambulates with two crutches, no braces and no physical assistance, 10 meters.

17 Ambulates with on devices, no braces and physical assistance of one person, 10 meters.

18 Ambulates with on devices, with braces and no physical assistance, 10 meters.

19 Ambulates with one cane/crutch, no braces and no physical assistance, 10 meters.

20 Ambulates with no devices, no braces and no physical assistance, 10 meters.

3.13 Intervention

In this study 40 patients participated and divide the patients into 2 groups. One is control group and other is experimental group. In each group has 20 patients. In experimental group patients had taken Functional Electrical Stimulation with conventional physiotherapy and the control group patients had taken only conventional therapy.

Control Group:

(Conventional Physiotherapy 30 min)

To improve Tone	Weight-bearing, Slow stretching
For Ambulation	Passive movement, Walking Bar (5 min)
Improving muscle Power	Actively assisted exercise, Resisted exercise

Experimental Group:

(Conventional Physiotherapy along with FES Therapy for 30 min)

FES Frequency: Frequency (35-55 HZ) that ambulates limb (Kapadia et al. 2011, p. 215).

To improve Tone	Weight-bearing, Slow stretching with FES
For Ambulation	Passive movement, Walking Bar (5 min) with FES
Improving muscle Power	Actively assisted exercise, Resisted exercise with FES

3.14 Data analysis

In order to ensure the research with substantive significance, it was imperative to articulate the mean values of the collected data in a manner comprehensible to other researchers, thereby rendering the results meaningful. Given that the results emanated from an experimental setting, data analysis was executed utilizing the SPSS software version 20. The Wilcoxon Signed Rank test was applied for the comparative and analytical assessment of the Ashworth Grade Score, Manual Muscle Testing Scale, and WISCI II Score both before and after the intervention. Furthermore, the Wilcoxon Signed Rank test test was employed for intergroup comparisons between the control and experimental groups.

3.15 Informed consent

Securing consent from research subjects is a fundamental ethical imperative in research endeavors (Baily, 1997). In this study, every participant was furnished with a consent form, accompanied by an oral elucidation of the research objectives and the content of the consent documents. Participation was entirely voluntary, and participants retained the autonomy to withdraw from the study at any juncture. The researcher assured individuals that their privacy would be upheld, and any disseminated information, whether in presentation or written form, would be anonymized. While the immediate implications of the study findings may not directly affect participants, the broader physiotherapy community stands to gain potential benefits in the future. Participants were assured that their dignity would be preserved throughout the research process. Furthermore, the researcher committed to remaining accessible for addressing any inquiries regarding the study at any given time.

3.16 Ethical consideration

The research proposal underwent scrutiny for approval by the ethical committee of CRP, adhering to the guidelines set forth by the Bangladesh Medical Research Council (BMRC) and the World Health Organization (WHO). Subsequently, prior to commencing data collection, authorization was obtained from the Ethical Committee of Bangladesh Health Professions Institute (BHPI). A formal letter of request was submitted to the relevant authority in the study area, seeking permission and assistance to facilitate unimpeded access for data collection while ensuring the safety of the patients. To mitigate ethical concerns, participants were afforded the liberty to receive treatment for other purposes as per their usual routines.

Before commencement, each participant was apprised of the study details and provided with a written consent form. The researcher obtained both verbal and signed consent from every participant to partake in the study. Participants were explicitly informed of their right to consult an external healthcare professional if they deemed the treatment insufficient or if their condition exacerbated. Additionally, participants were assured of their autonomy to refrain from answering any specific questions during the study and were free to rescind their consent, discontinuing participation at any juncture. Importantly, withdrawal from the study would not impact their ongoing treatment within the physiotherapy department, and they would continue to receive the same level of facilities. Each participant was granted the opportunity to address concerns or queries with the senior authorities or administration at CRP, ensuring satisfaction and clarity regarding their participation.

CHAPTER: IV RESULTs

A total of 40 patients were taken in this study to find out the effectiveness of Functional Electrical Stimulation in hip flexors and extensors of paraplegic patients. In that case, 20 patients were in the control group and 20 patients in the experimental group. The following paragraphs provide a summary of the investigation's findings.

4.1: Age of Participants in the control group

Table 1: Age of Participants in the control group

Participants	**Age**
1	22
2	17
3	18
4	28
5	24
6	74
7	40
8	22
9	52
10	28
11	18
12	42
13	55
14	24
15	42
16	26
17	35
18	20
19	33
20	39

Mean; (±SD) 32.95; (±14.788).

The total sample was 40 in both the control and experimental groups. There were 20 participants in the control group. The maximum age was 74, the minimum age was 17.

4.2: Age of Participants in the experimental group

Table 2: Age of Participants in the experimental group

Participants	**Age**
1	25
2	36
3	25
4	40
5	26
6	10
7	30
8	64
9	30
10	18
11	24
12	22
13	24
14	28
15	40
16	22
17	17
18	24
19	30
20	42

Mean; (±SD) 28.85; (± 11.54).

The total sample was 40 in both the control and experimental groups. There were 20 participants in the experimental group. The maximum age was 64, the minimum age was 10.

4.3: Education qualification of control group

Of the 20 participants in the control group, 9 participants completed their primary education, 5 participants completed secondary education, 4 have no formal education, 1 have completed higher secondary education and 1 participant had completed graduation.

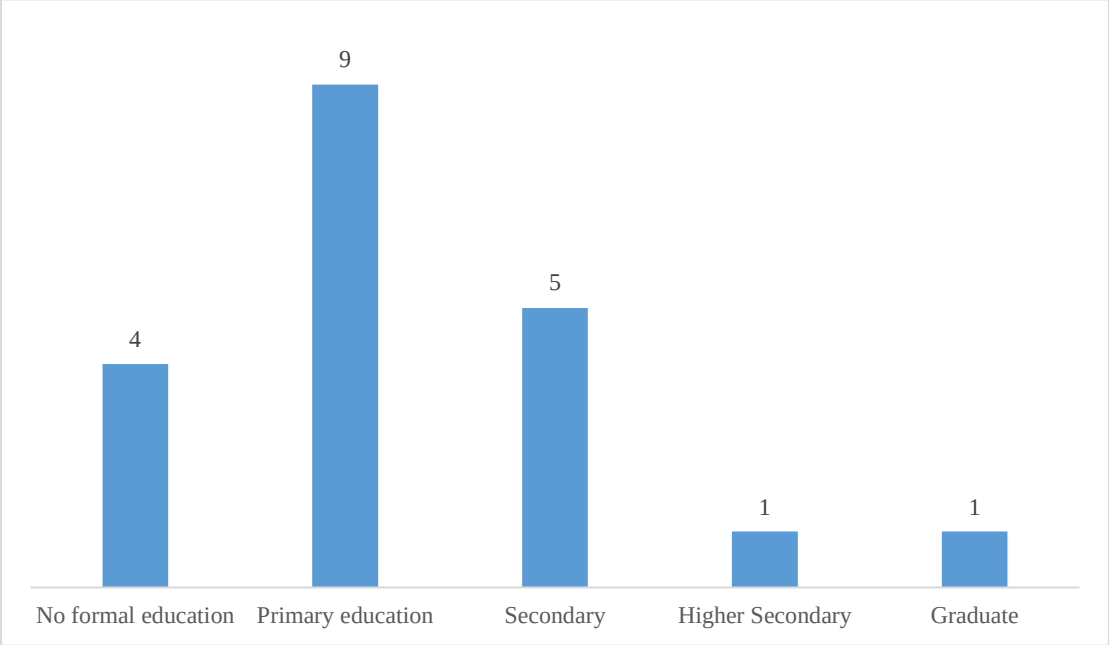

Figure 1: Education qualification of control group

4.4: Education qualification of experimental group

Of the 20 participants in the control group, 6 have completed primary education, 6 have completed secondary education, 4 have completed higher secondary education, 2 completed their graduation and had no formal education.

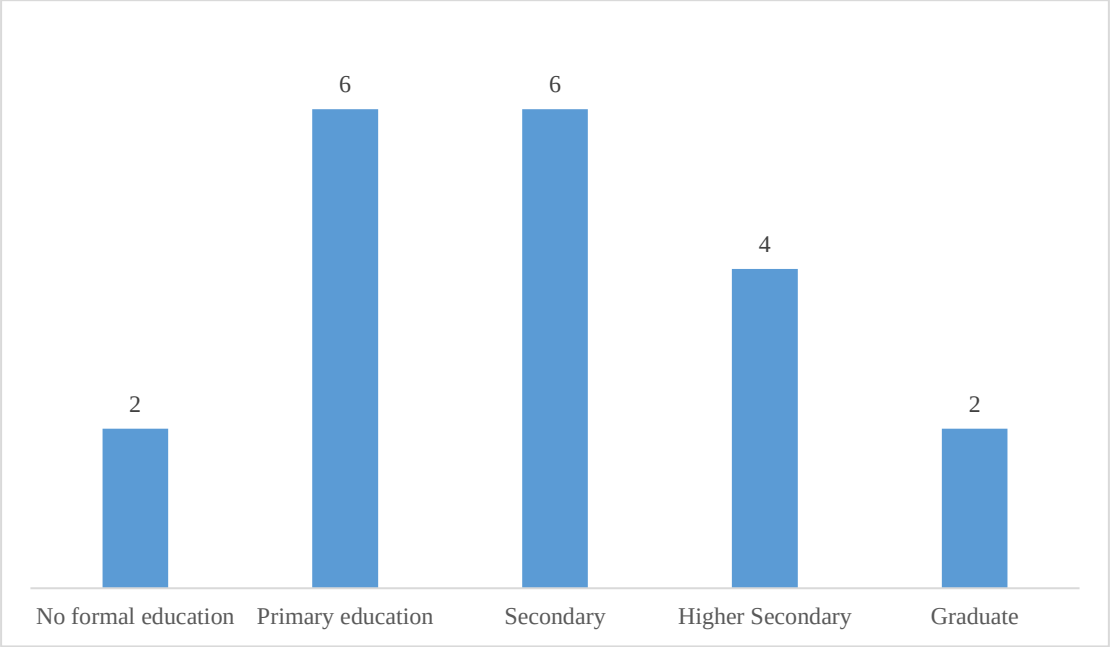

Figure 2: Education qualification of control group

4.5: Occupational status of the control group

Among the participants of the control group, 9 participants belong to others, 3 participants are service holders, 3 participants are students, 2 participants are day farmers, 2 participants are day labor and 1 participant is unemployed.

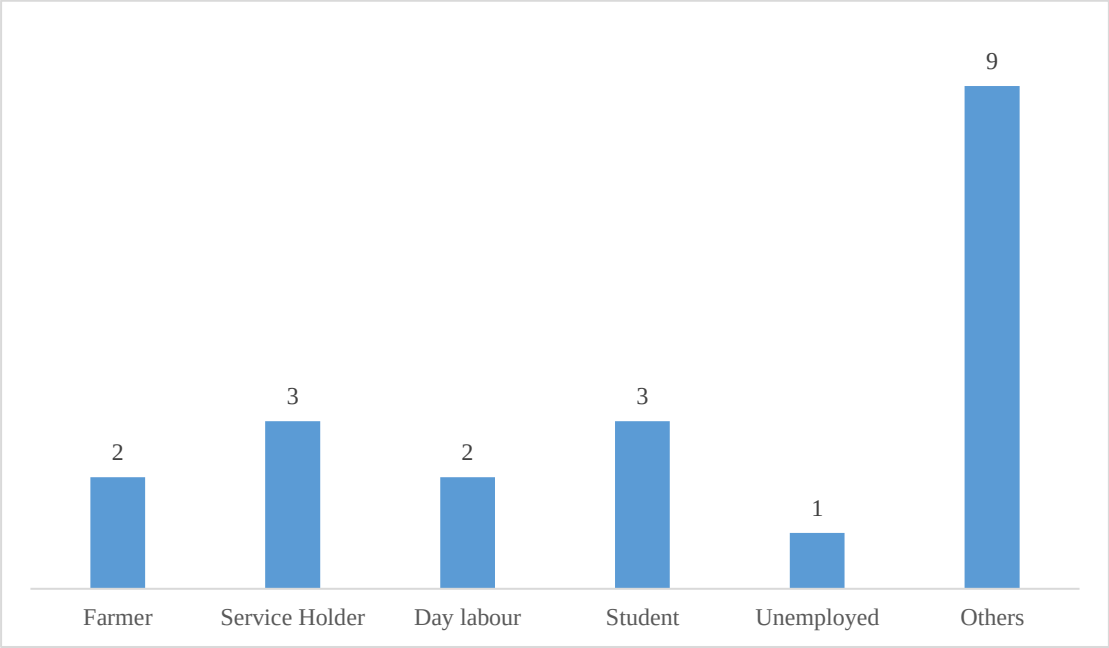

Figure 3: Occupational status of the control group

4.6: Occupational status of the experimental group

Among the participants of the experimental group, 14 participants belong from others, participants are service holders and 2 participants are students.

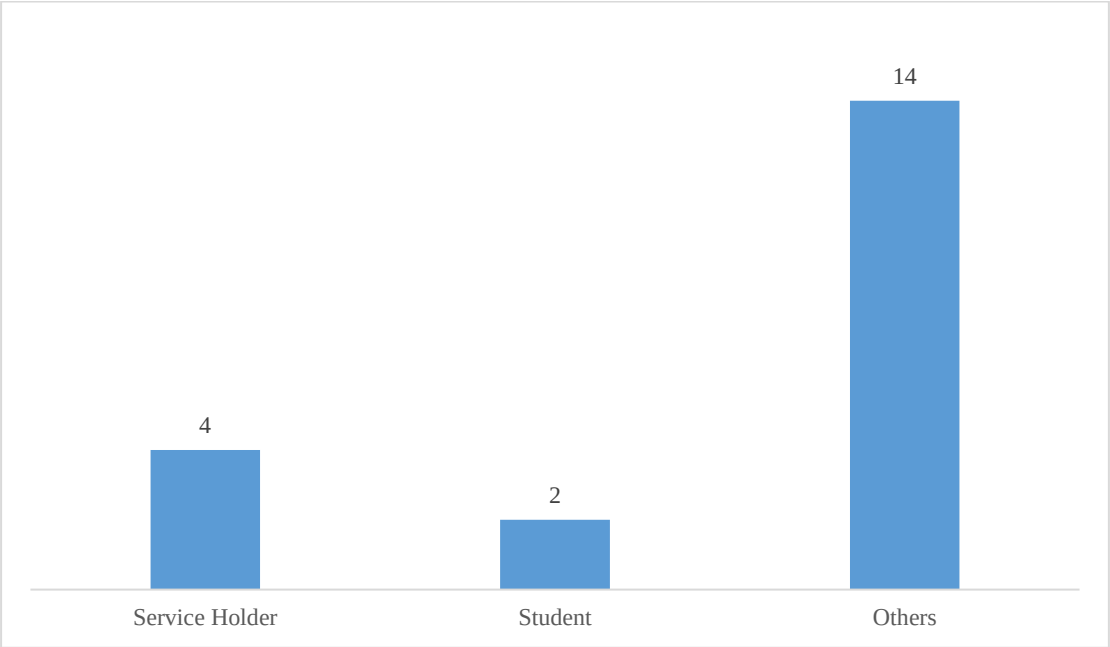

Figure 4: Occupational status of the experimental group

4.7: Financial status of control group

Among the control group participants, 14 participants are financially dependent and 6 participants are dependent financially on others.

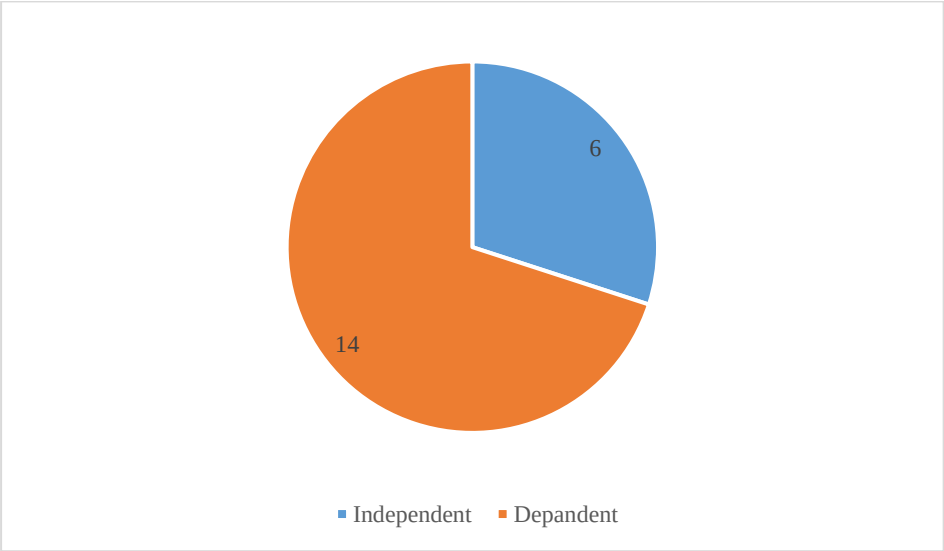

Figure 5: Financial status of control group

4.8: Financial status of the experimental group

Among the control group participants, 13 participants are financially independent and 7 participants are dependent financially.

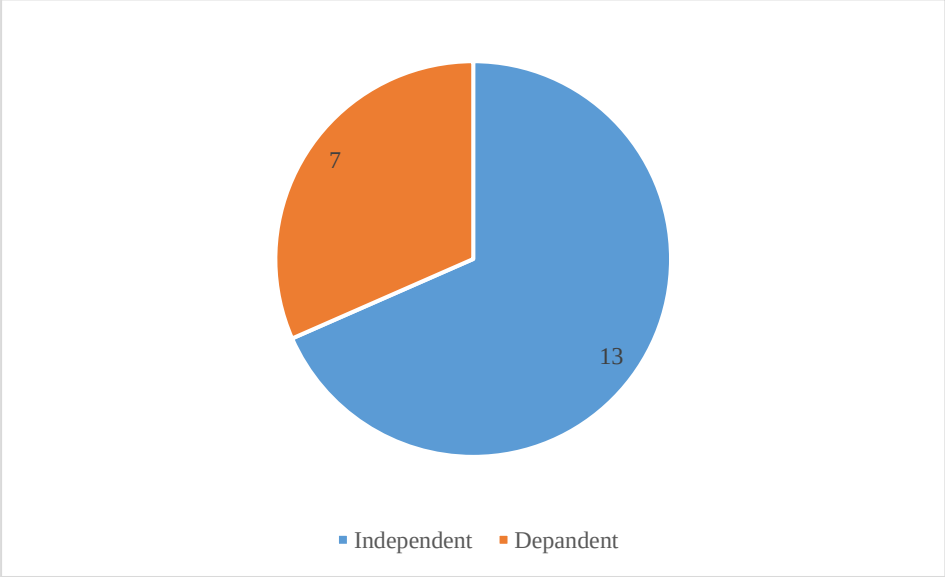

Figure 6: Financial status of the experimental group

4.9: Monthly income status among the control group

11 participants from the control group income range from 10001 – 20000 taka, 8 people income range from 20001 – 30000 taka, 1 participant's income is below 10000 taka.

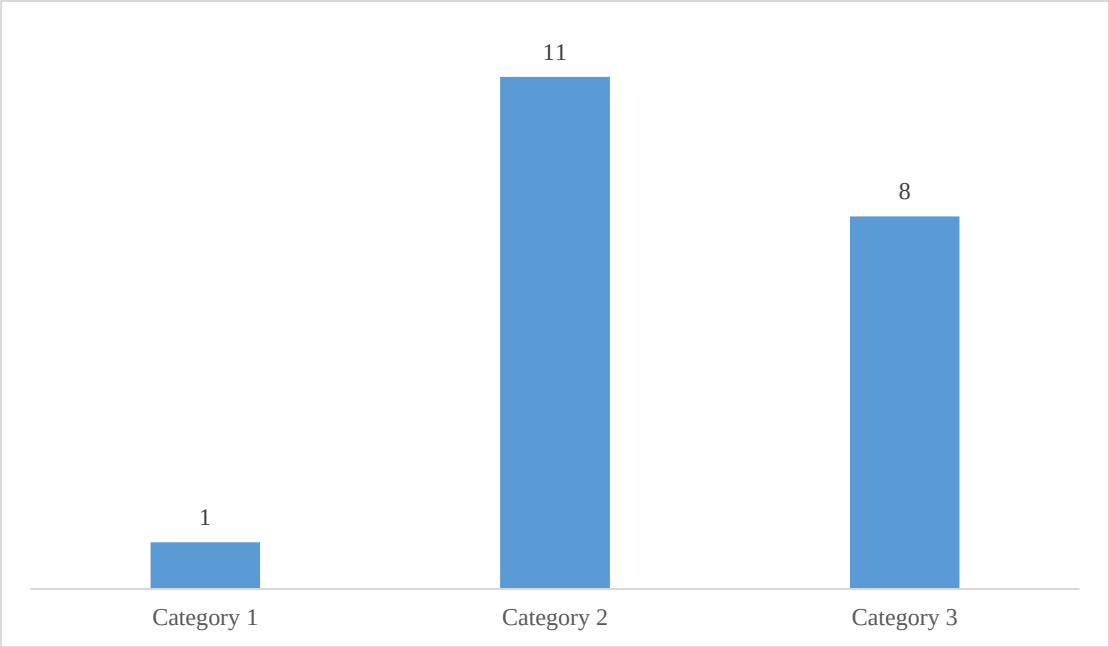

Figure 7: Monthly income status among the control group

4.10: Monthly income status among the experimental group

15 participants from the control group had income ranging from 10001 – 20000-taka, 5 people's income ranged from 20001 – 30000 taka, and 1 participant's income was below 10000 taka.

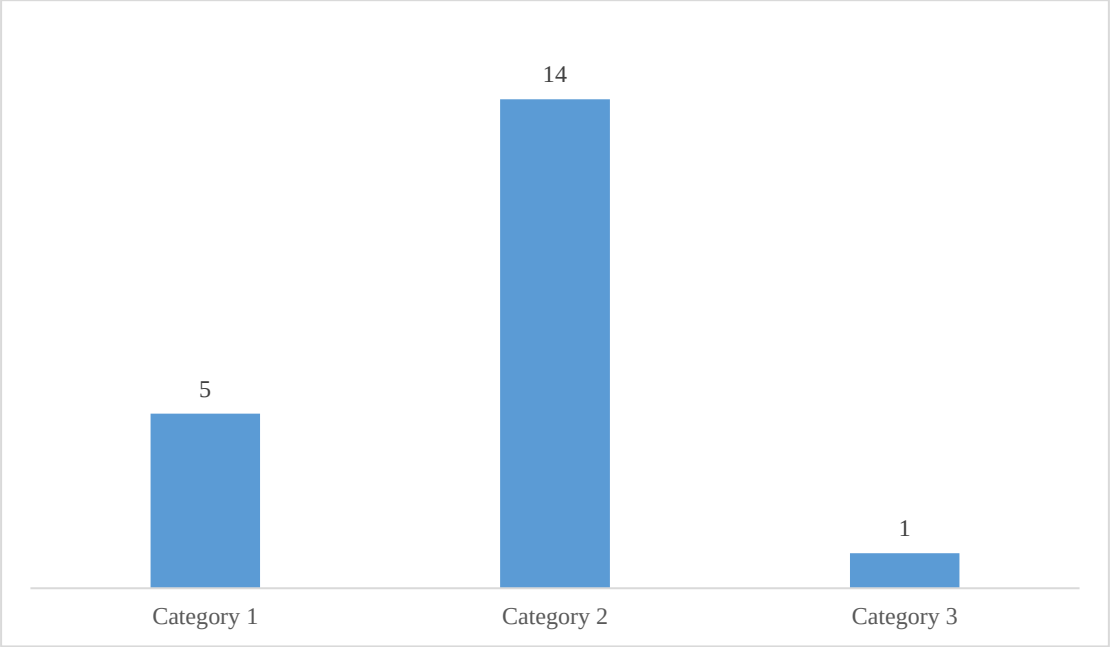

Figure 8: Monthly income status among the experimental group

4.11: Treatment expenses status of control group

Among the 20 participants of the control group, the treatment expenses ranged below ten thousand for 14 people, four participants' treatment expenses ranged between ten thousand and twenty thousand, and two participants' treatment expenses ranged over twenty thousand.

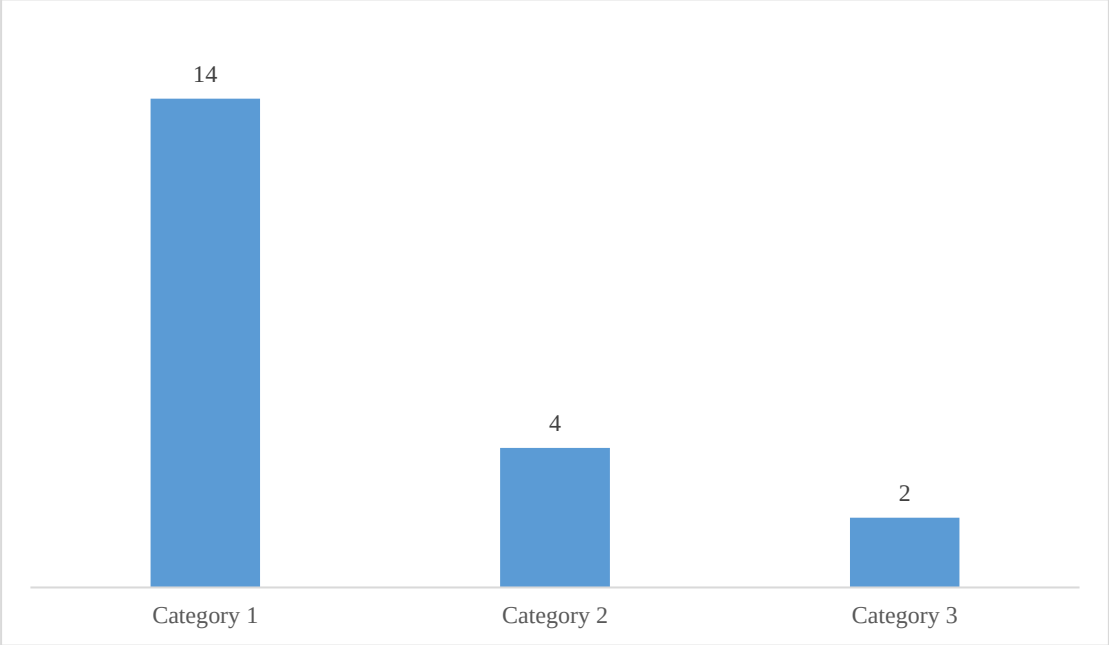

Figure 9: Treatment expenses status

4.12: Treatment expenses status of the experimental group

Among the 20 participants of the experimental group, the treatment expenses ranged below ten thousand for 14 people, 5 participants' treatment expenses ranged between ten thousand and twenty thousand, and 1 participant's treatment expenses ranged over twenty thousand.

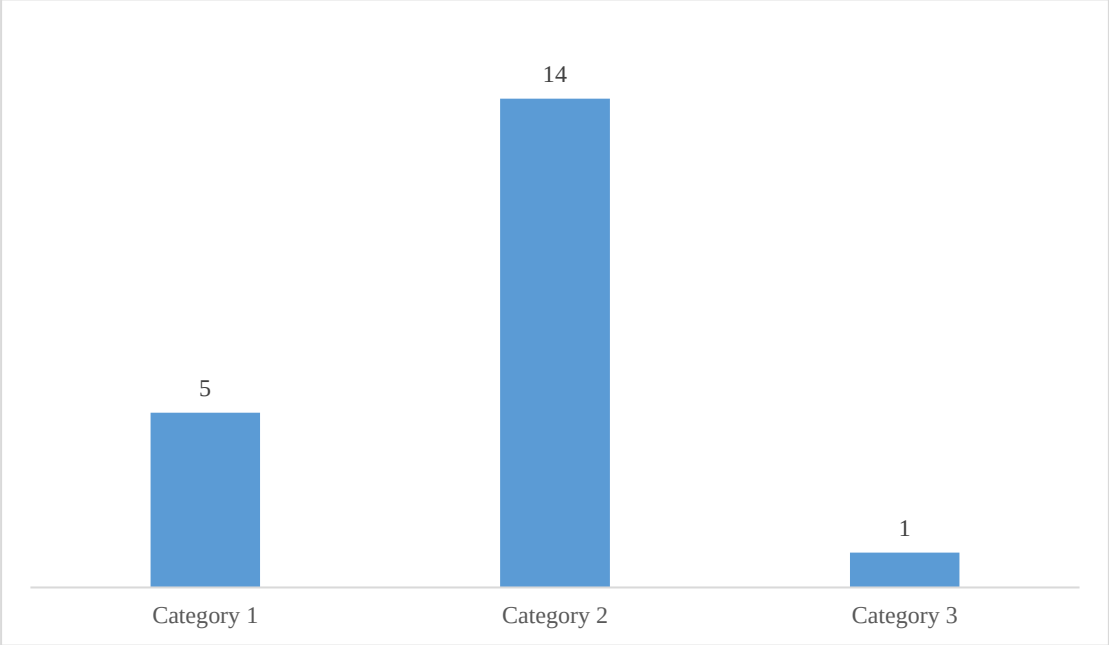

Figure 10: Treatment expenses status of the experimental group

4.13: Status of duration of incidence of control group

Among the 20 participants of the control group, 10 participants' duration of incidence was between 4-6 months, 8 people were between 7-9 months, one participant was between 10-12 months and one participant was below three months.

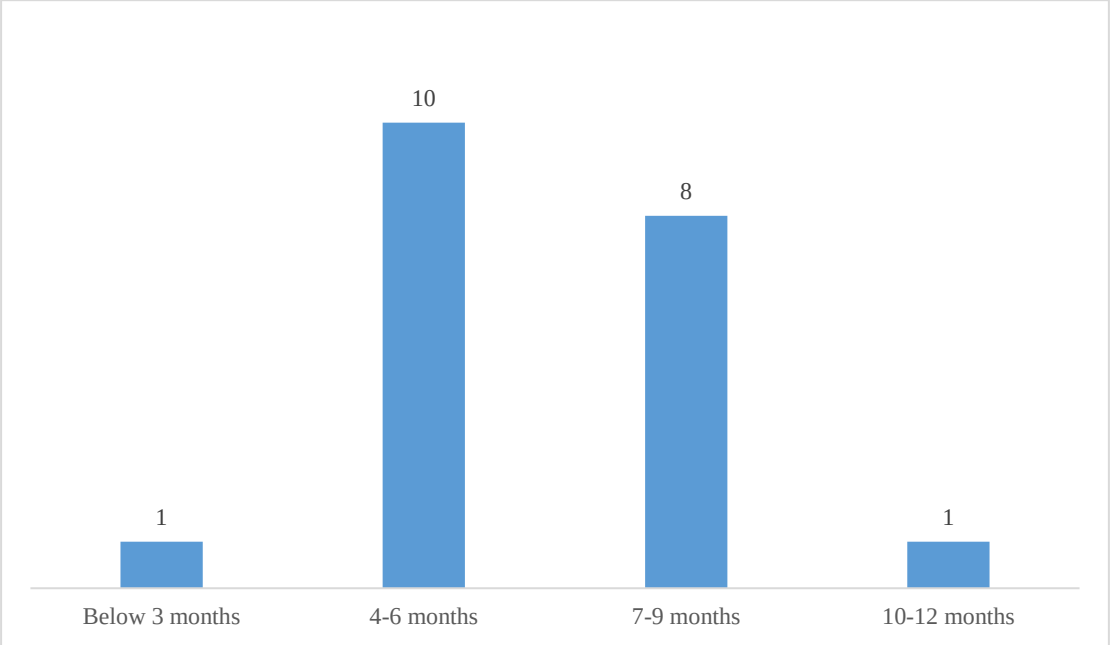

Figure 11: Status of the duration of incidence of the control group

4.14: Status of the duration of incidence of the experimental group

Among the 20 participants of the experimental group, 11 participants' duration of incidence was between 4-6 months, 5 people were between 7-9 months, 2 participants were between 10-12 months and 2 participants were below three months.

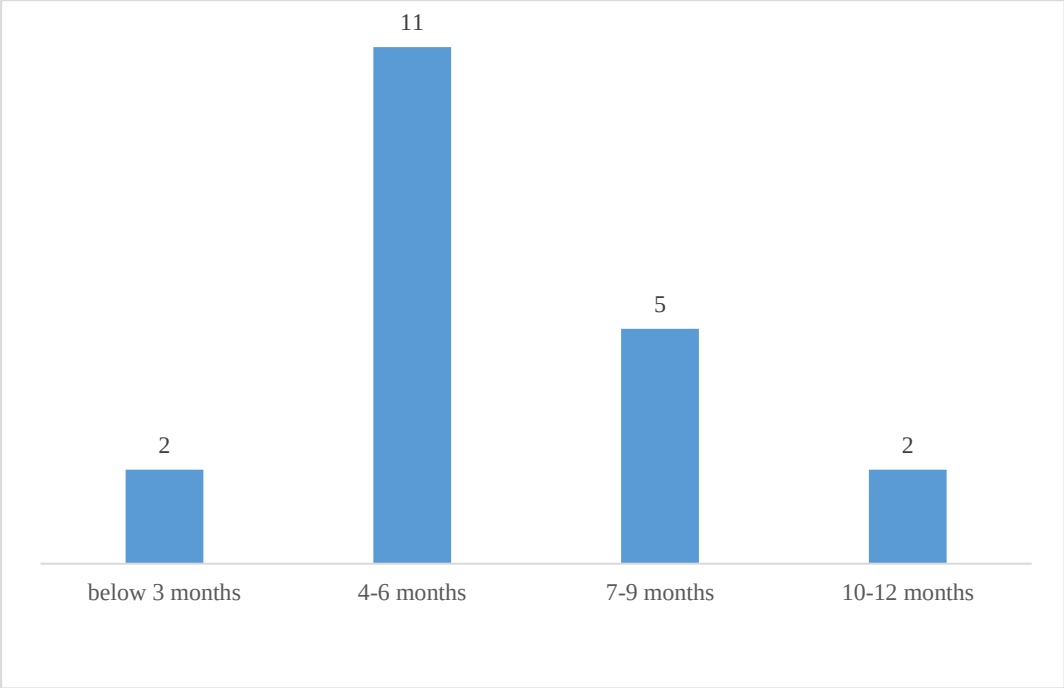

Figure 12: Status of the duration of incidence of the experimental group

4.15: Status of health care received (control group)

Among the 20 participants of the control group 17 participants use to go hospital and rest 3 participants used to go private clinics.

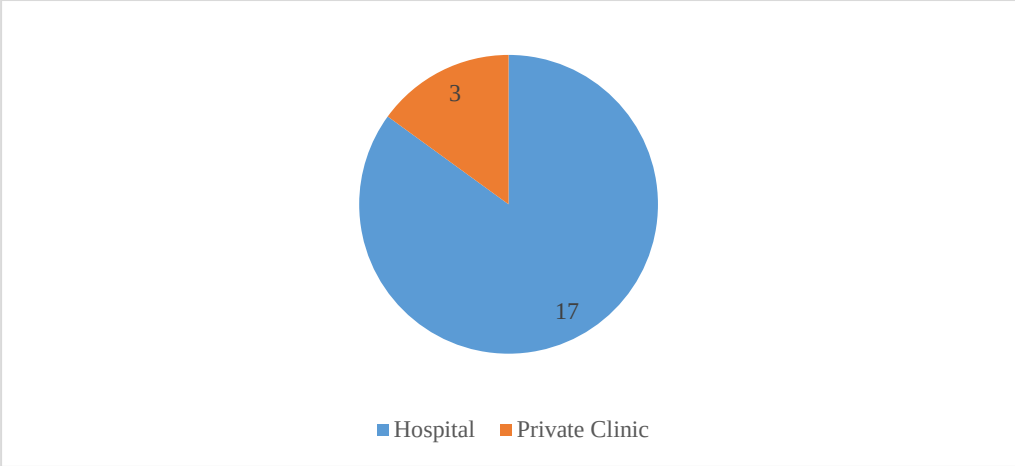

Figure 13: Status of health care received (control group)

4.16: Status of health care received (experimental group)

Among the 20 participants of the control group, 14 participants used to go to hospital and r 3 participants used to go to private clinics, and res three participants used to go to other facilities.

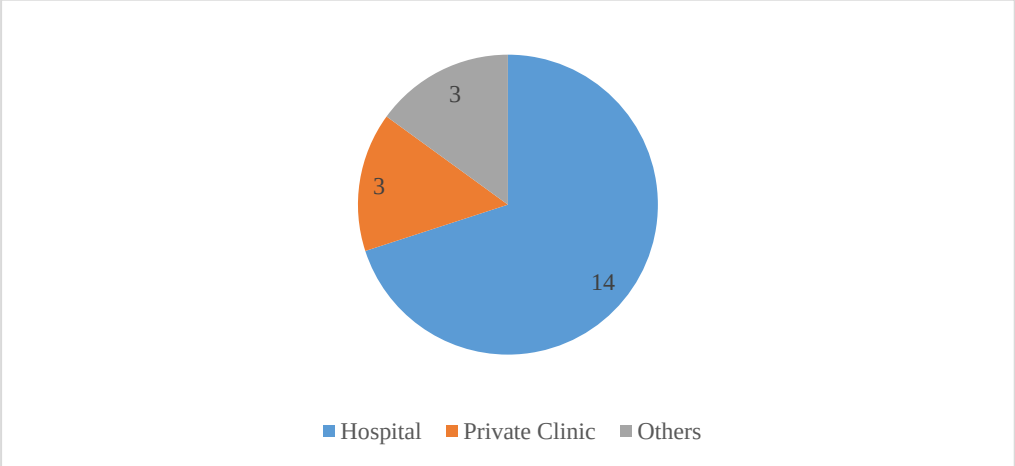

Figure 14: Status of health care received (Experimental group)

4.16: Comorbidity status of the Control group

Among the 20 participants of the control group, 9 participants had multiple co-morbid conditions, 2 participants had heart disease, 2 participants had hypertension, 2 participants had kidney diseases, 2 participants had diabetes, 1 participant had respiratory disease,

1 person had stomach and ulcer disease and 1 person had anemia.

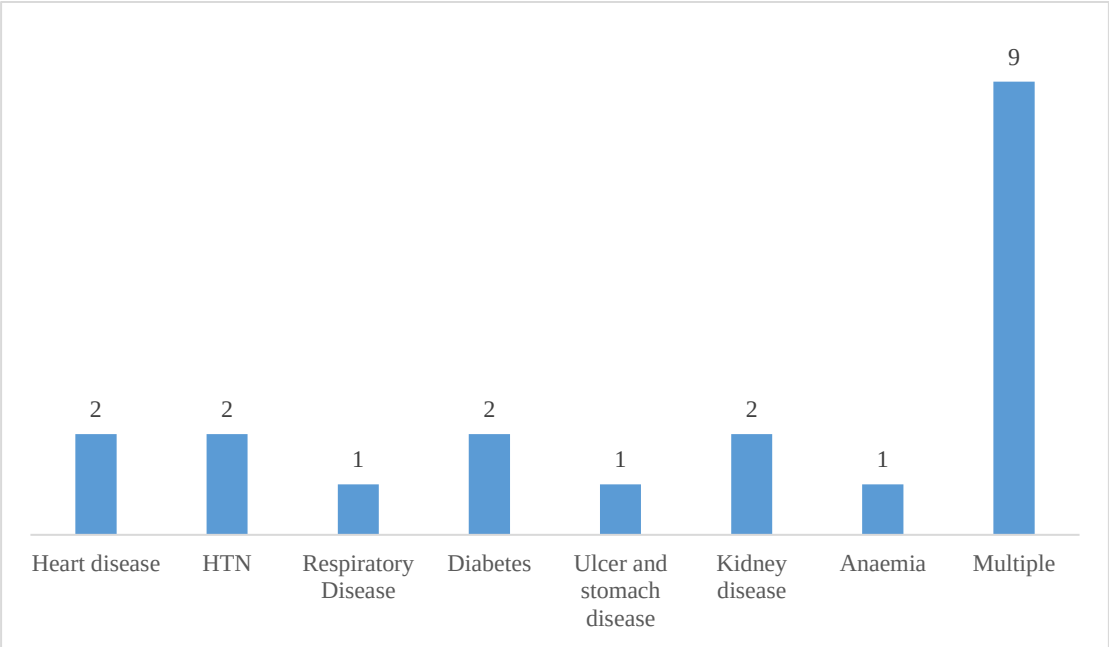

Figure 15: Comorbidity status of the Control group

4.17: Comorbidity status of the experimental group

Among the 20 participants of the experimental group, 10 participants had multiple co-morbid conditions, 3 people had stomach and ulcer disease, 2 participants had hypertension, 2 participants had kidney diseases, 2 participants had diabetes, 2 participants had respiratory disease, 1 person had anemia and 1 participant had heart disease.

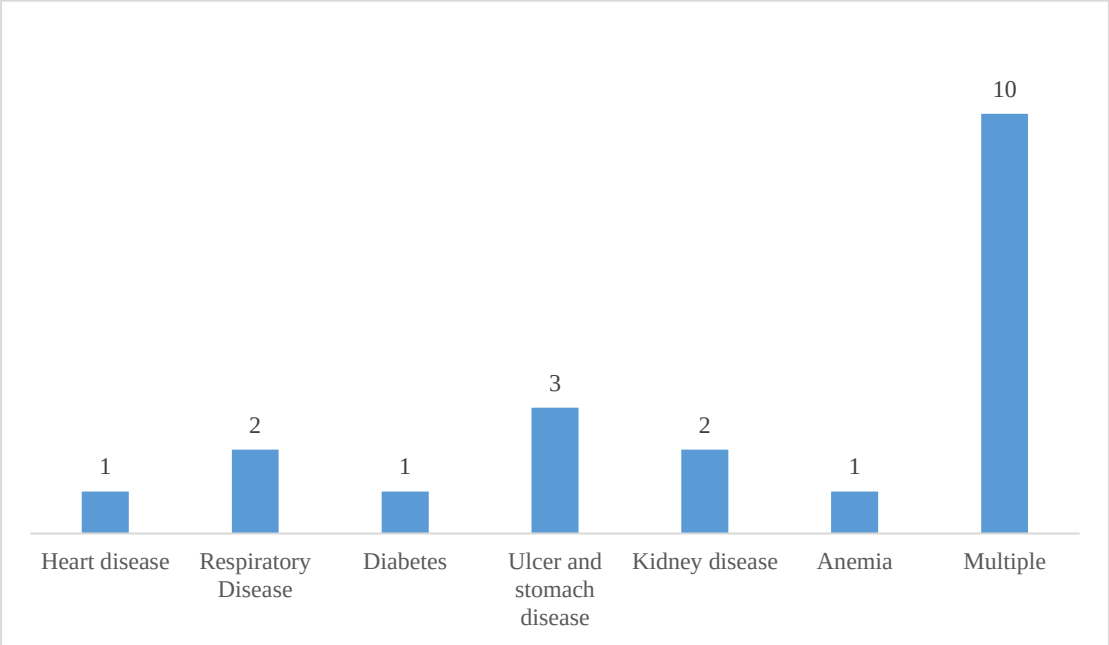

Figure 16: Comorbidity status of the experimental group

4.18: Causes of injury among the control group

All 20 participants of the control group had traumatic paraplegia. Among them 14 patients' causes were fall from height, 4 causes were road traffic accidents (RTA), and 2 causes were falling heavy objects.

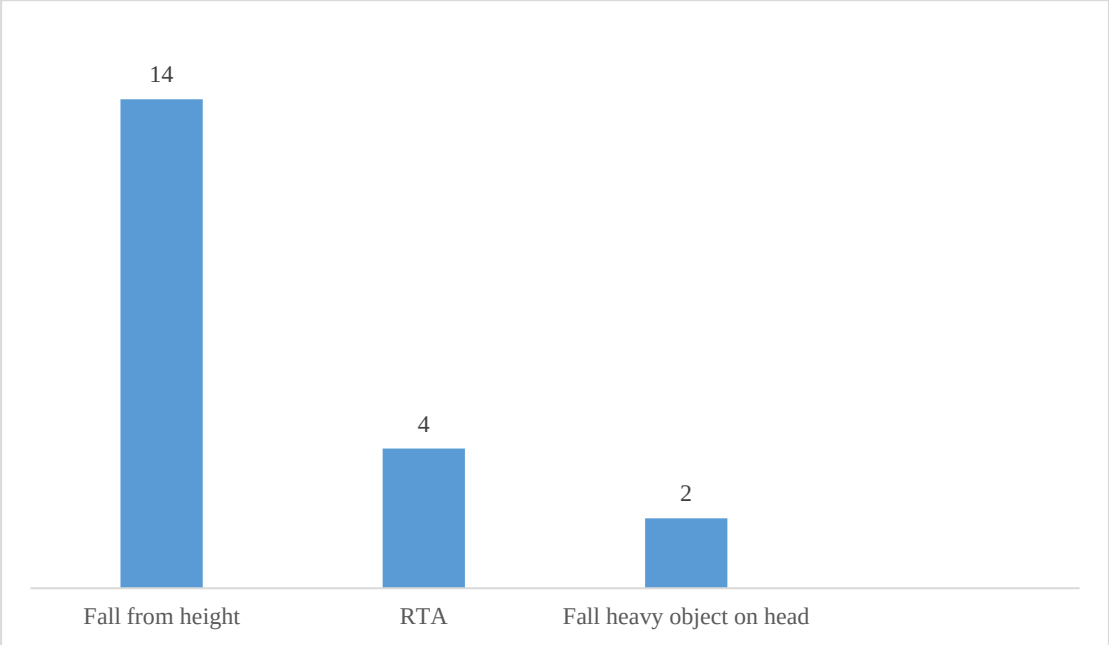

Figure 17: Causes of injury among the control group

4.19: Causes of injury among the experimental group

All 20 participants of the experimental group had traumatic paraplegia. Among them 10 patients' causes were fall from height, 8 causes were road traffic accidents (RTA), and 2 causes were falling heavy objects.

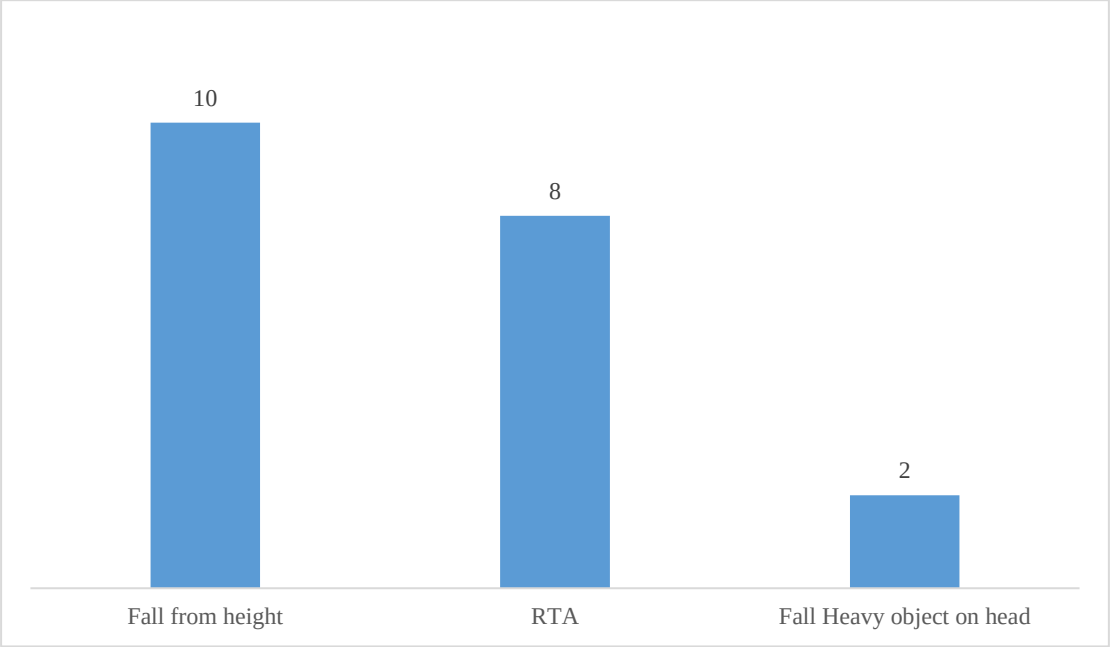

Figure 18: Causes of injury among the experimental group

4.19: Facilities taken by the participants of control group

Participants in the control group had taken facilities from various rehabilitation centers and hospitals. 14 participants took facilities from different institutes, 3 participants took treatment from NITOR, 2 participants had taken from CRP, and 1 participant from NINS.

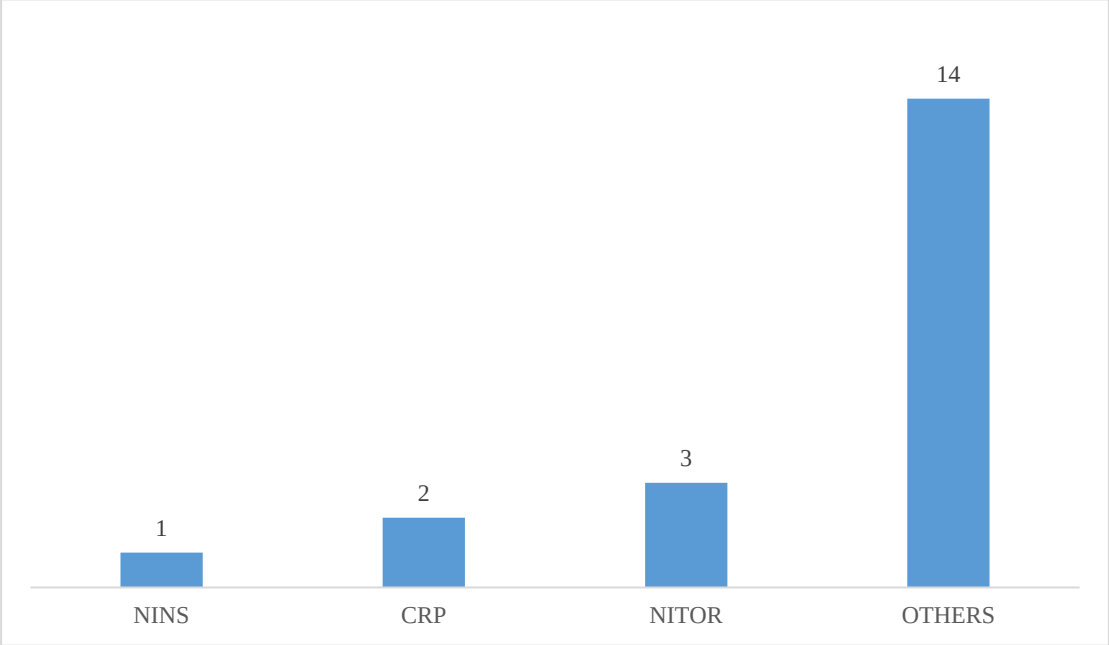

Figure 19: Facilities taken by the participants

4.20: Facilities taken by the participants of experimental group

Participants in the experimental group had taken facilities from various rehabilitation centers and hospitals. 7 participants took facilities from different institutes, 7 participants from NINS, 4 participants took treatment from NITOR, and 2 participants taken from CRP.

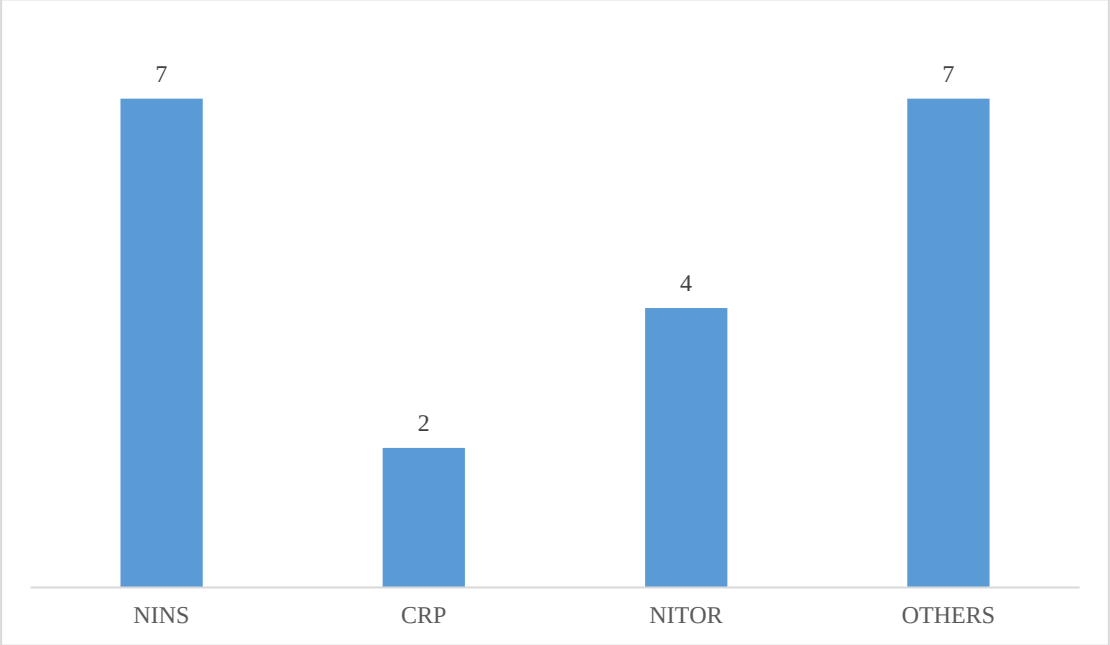

Figure 20: Facilities taken by the participants

4.21: Analysis of muscle tone of the control group

Wilcoxon Signed Rank test by comparing between Pre-test Ashworth Grade Score

Table 3: Calculation of Z value for Pre-test and Post-test of muscle tone

Pre-test and Post-test Muscle Tone			
Modified Ashworth Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	6	- 2.493	0.013*
Negative ranks	4		
Ties	4		
Total	14		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Ashworth Grade scores. The Ashworth Grade score of 20 participants was not significantly higher after the intervention. The point 'ties' indicate that no patient's total independence score remained same as the pre-test score. P value is <0.05 which describes that there is less than a 5% chance that the results are due to random error, and it is significant. Therefore, it can be said that there is been found a significant improvement in muscle tone because more positive values indicate increase tone.

4.22: Analysis of muscle tone of the experimental group

Wilcoxon Signed Rank test by comparing between Pre-test and Post-test Ashworth Grade Score.

Table 4: Calculation of Z value for Pre-test and Post-test of muscle tone

Pre-test and Post-test Muscle Tone			
Modified Ashworth Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	0	- 3.626	0.206*
Negative ranks	25		
Ties	5		
Total	30		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Ashworth Grade scores. The Ashworth Grade score of 20 participants was significantly higher after the intervention. The point 'ties' indicate that no Ashworth Grade score remained the same as the pre-test score. P value is <0.05 which describes that there is less than a 5% chance that the results are due to random error, and it is significant. Therefore, it can be said that there has been a significant improvement in muscle tone through interventions.

4.23: Analysis of Muscle Testing of Right Knee Extensors (Control Group)

Wilcoxon Signed Rank test by comparing between Pre-test Manual Muscle Testing.

Table 5: Calculation of Z value for Pre-test and Post-test of Manual Muscle Testing

Pre-test and Post-test Manual Muscle Testing			
MMT Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	3	- 1.256	0.132*
Negative ranks	7		
Ties	10		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Manual Muscle Testing scores. The Manual Muscle Testing score of 20 participants was not significant after the 20 sessions of intervention. The point 'ties' indicate that no Manual Muscle Testing score remained the same as the pre-test score. P value is not <0.05 and it is not significant. Therefore, it can be said that there is no significant improvement in Muscle Testing Scores through only conventional treatment.

4.24: Analysis of Muscle Testing of Right Knee Extensors (Experimental Group)

Wilcoxon Signed Rank test by comparing between Post-test Manual Muscle Testing.

Table 6: Calculation of Z value for Pre-test and Post-test of Manual Muscle Testing

Pre-test and Post-test Manual Muscle Testing			
MMT Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	18	-3.958	0.001*
Negative ranks	1		
Ties	1		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Ashworth Grade scores. The Manual Muscle Testing (MMT) score of 20 participants was significantly higher after the intervention. The point 'ties' indicate that no Ashworth Grade score remained the same as the pre-test score. P value is <0.05 which describes that there is less than a 5% chance that the results are due to random error, and it is significant. Therefore, it can be said that there has been a significant improvement in MMT through 20 session of Functional Electrical Stimulation (FES) interventions as well as conventional therapy.

4.23: Analysis of Muscle Testing of Left Knee Extensors (Control Group)

Wilcoxon Signed Rank test by comparing between Pre-test Manual Muscle Testing.

Table 7: Calculation of Z value for Pre-test and Post-test of Manual Muscle Testing

Pre-test and Post-test Manual Muscle Testing			
MMT Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	3	- 1.508	0.132*
Negative ranks	8		
Ties	9		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Manual Muscle Testing scores. The Manual Muscle Testing score of 20 participants was not significant after the 20 sessions of intervention. The point 'ties' indicate that no Manual Muscle Testing score remained the same as the pre-test score. The P value is not <0.05 and it is not significant. Therefore, it can be said that there is no significant improvement in Muscle Testing Scores through only conventional treatment.

4.24: Analysis of Muscle Testing of Left Knee Extensors (Experimental Group)

Wilcoxon Signed Rank test by comparing between Post-test Manual Muscle Testing.

Table 8: Calculation of Z value for Pre-test and Post-test of Manual Muscle Testing

Pre-test and Post-test Manual Muscle Testing			
MMT Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	19	- 3.962	0.001*
Negative ranks	1		
Ties	0		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Manual Muscle Testing scores. The Manual Muscle Testing score of 20 participants was not significant after the 20 sessions of intervention. The point 'ties' indicate that no Manual Muscle Testing score remained the same as the pre-test score. The P value is not <0.05 and it is not significant. Therefore, it can be said that there is significant improvement in Muscle Testing Scores through conventional treatment along with functional electrical stimulation.

4.25: Analysis of Muscle Testing of Right Hip Extensors (Control Group)

Wilcoxon Signed Rank test by comparing between Pre-test Manual Muscle Testing.

Table 9: Calculation of Z value for Pre-test and Post-test of Manual Muscle Testing

Pre-test and Post-test Manual Muscle Testing			
MMT Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	2	- 2.111	0.035*
Negative ranks	9		
Ties	9		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Manual Muscle Testing scores. The Manual Muscle Testing score of 20 participants was not significant after the 20 sessions of intervention. The point 'ties' indicate that no Manual Muscle Testing score remained the same as the pre-test score. The P value is not <0.05 and it is not significant. Therefore, it can be said that there is no significant improvement in Muscle Testing Scores through only conventional treatment.

4.26: Analysis of Muscle Testing of Right Hip Extensors (Experimental Group)

Wilcoxon Signed Rank test by comparing between Post-test Manual Muscle Testing.

Table 10: Calculation of Z value for Pre-test and Post-test of Manual Muscle Testing

Pre-test and Post-test Manual Muscle Testing			
MMT Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	20	- 4.234	0.001*
Negative ranks	0		
Ties	0		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Manual Muscle Testing scores. The Manual Muscle Testing score of 20 participants was not significant after the 20 sessions of intervention. The point 'ties' indicate that no Manual Muscle Testing score remained the same as the pre-test score. The P value is not <0.05 and it is not significant. Therefore, it can be said that there is significant improvement in Muscle Testing Scores through conventional treatment along with functional electrical stimulation.

4.27: Analysis of Muscle Testing of Left Hip Extensors (Control Group)

Wilcoxon Signed Rank test by comparing between Pre-test Manual Muscle Testing.

Table 11: Calculation of Z value for Pre-test and Post-test of Manual Muscle Testing

Pre-test and Post-test Manual Muscle Testing			
MMT Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	2	- 1.848	0.065*
Negative ranks	10		
Ties	8		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Manual Muscle Testing scores. The Manual Muscle Testing score of 20 participants was not significant after the 20 sessions of intervention. The point 'ties' indicate that no Manual Muscle Testing score remained the same as the pre-test score. The P value is not <0.05 and it is not significant. Therefore, it can be said that there is no significant improvement in Muscle Testing Scores through only conventional treatment.

4.28: Analysis of Muscle Testing of Left Hip Extensors (Experimental Group)

Wilcoxon Signed Rank test by comparing between Post-test Manual Muscle Testing.

Table 12: Calculation of Z value for Pre-test and Post-test of Manual Muscle Testing

Pre-test and Post-test Manual Muscle Testing			
MMT Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	20	- 4.099	0.001*
Negative ranks	0		
Ties	0		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Manual Muscle Testing scores. The Manual Muscle Testing score of 20 participants was not significant after the 20 sessions of intervention. The point 'ties' indicate that no Manual Muscle Testing score remained the same as the pre-test score. The P value is not <0.05 and it is not significant. Therefore, it can be said that there is significant improvement in Muscle Testing Scores through conventional treatment along with functional electrical stimulation.

4.29: Analysis of Walking Index (Control Group)

Wilcoxon Signed Rank test by comparing between Pre-test and Post-test Manual Muscle Testing.

Table 13: Calculation of Z value for Pre-test of walking Index Score

Pre-test and Post-test Walking Index Score			
WISCI II Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	4	- 0.046	0.963*
Negative ranks	7		
Ties	9		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of walking Index Score. Walking Index Score of 20 participants was not significant after the 20 sessions of intervention. The point 'ties' indicate that Walking Index Score remained the same as the pre-test score. The P value is not <0.05 and it is not significant. Therefore, it can be said that there is no significant improvement in Walking Index Score through only conventional treatment.

4.28: Analysis of Walking Index (Experimental Group)

Wilcoxon Signed Rank test by comparing between Pre-test and Post-test Manual Muscle Testing.

Table 14: Calculation of Z value for Post-test of Manual Muscle Testing

Pre-test and Post-test Walking Index Score			
WISCI II Score	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	0	- 4.379	0.001*
Negative ranks	20		
Ties	0		
Total	20		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Walking Index Score. The Walking Index Score of 20 participants was significant after the 20 sessions of intervention. The point 'ties' indicate that no Manual Muscle Testing score remained the same as the pre-test score. The P value is not <0.05 and it is significant. Therefore, it can be said that there is significant improvement in Walking Index Score through only conventional treatment along with electrical stimulation.

4.29: Analysis of Muscle Tone (Ashworth Grade Score)

Independent Sample Kruskal Wallis Test

Table 15: Calculation of P value for Pre-test and Post-test muscle tone

Null Hypothesis	Test	Significance	Decision
The Distribution of the Modified Ashworth Score baseline (Pre-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.010*	Reject The Null Hypothesis
The Distribution of Modified Ashworth Score 10 sessions (Post Test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.020*	Reject The Null Hypothesis
The Distribution of Modified Ashworth Score 20 sessions (post Test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.017*	Reject The Null Hypothesis

Here, N= 40. Asymptotic significances are displayed. The P value of 10 sessions and 20 sessions of FES intervention are significant and the P value is <0.05

4.30: Analysis of Manual Muscle Testing Score (Right knee extensors)

Independent Sample Kruskal Wallis Test

Table 16: Calculation of P value for Pre-test and Post-test muscle strength

Null Hypothesis	Test	Significance	Decision
The Distribution of the Manual muscle Testing Score baseline (Pre-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.079*	Retain the null hypothesis
The Distribution of Manual muscle Testing 10 sessions (post-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.016*	Reject The Null Hypothesis
The Distribution of Manual muscle Testing 20 sessions (post-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.001*	Reject The Null Hypothesis

Here, N= 40. Asymptotic significances are displayed. The P value of 10 sessions and 20 sessions of FES intervention are significant and the P value is <0.05.

4.30: Analysis of Manual Muscle Testing Score (left knee extensors)

Independent Sample Kruskal Wallis Test

Table 17: Calculation of P value for Pre-test and Post-test muscle strength

Null Hypothesis	Test	Significance	Decision
The Distribution of the Manual muscle Testing Score baseline (Pre-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.075	Retain the null hypothesis
The Distribution of Manual muscle Testing 10 sessions (post-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.020	Reject The Null Hypothesis
The Distribution of Manual muscle Testing 20 sessions (post-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.001	Reject The Null Hypothesis

Here, N= 40. Asymptotic significances are displayed. The P value of 10 sessions and 20 sessions of FES intervention are significant and the P value is <0.05.

4.31: Analysis of Manual Muscle Testing Score (Right hip extensors)

Independent Sample Kruskal Wallis Test

Table 18: Calculation of P value for Pre-test and Post-test muscle strength

Null Hypothesis	Test	Significance	Decision
The Distribution of the Manual muscle Testing Score baseline (Pre-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.049*	Reject the null hypothesis
The Distribution of Manual muscle Testing 10 sessions (post-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.036*	Reject The Null Hypothesis
The Distribution of Manual muscle Testing 20 sessions (post-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.001*	Reject The Null Hypothesis

Here, N= 40. Asymptotic significances are displayed. The P value of 10 sessions and 20 sessions of FES intervention are significant and the P value is <0.05.

4.32: Analysis of Manual Muscle Testing Score (left hip extensors)

Independent Sample Kruskal Wallis Test

Table 19: Calculation of P value for Pre-test and Post-test muscle strength

Null Hypothesis	Test	Significance	Decision
The Distribution of the Manual muscle Testing Score baseline (Pre-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.966*	Reject the null hypothesis
The Distribution of Manual muscle Testing 10 sessions (post-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.010*	Reject The Null Hypothesis
The Distribution of Manual muscle Testing 20 sessions (post-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.032*	Reject The Null Hypothesis

Here, N= 40. Asymptotic significances are displayed. The P value of 10 sessions and 20 sessions of FES intervention are significant and the P value is <0.05.

4.33: Analysis of Walking Index for SCI (WISCI II)

Independent Sample Kruskal Wallis Test

Table 20: Calculation of P value for Pre-test and Post-test muscle strength

Null Hypothesis	Test	Significance	Decision
The Distribution of the WISCI II Score baseline (Pre-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.119*	Reject the null hypothesis
The Distribution of the WISCI II Score baseline (Pre-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.001*	Reject The Null Hypothesis
The Distribution of the WISCI II Score baseline (Pre-test) is the same across categories of group	Independent Sample Kruskal Wallis Test	0.001*	Reject The Null Hypothesis

Here, N= 40. Asymptotic significances are displayed. The P value of 10 sessions and 20 sessions of FES intervention are significant and the P value is <0.05.

CHAPTER: V DISCUSSION

The research, titled "Effectiveness of Functional Electrical Stimulation (FES) on Knee Extensors and Hip Extensors in Paraplegic participants at a Specialized Rehabilitation Unit," involved the participation of 40 patients, with 20 allocated to the control group and 20 to the experimental group. The experimental group underwent Functional Electrical Stimulation (FES) in conjunction with conventional physiotherapy, while the control group received solely conventional therapy. The intervention spanned 20 sessions over a duration of four weeks, with the physiotherapy administered by qualified physiotherapists.

The findings of the study provide insights into the efficacy of FES by highlighting the significant improvements observed in lower limb function, as well as improvements of tone, ambulation and muscle power and ambulation, when FES is applied with conventional therapy and lead to rehabilitation effectively. Various types of conventional therapy provide improvements in tone, ambulation and muscle power. When we apply FES with conventional therapy the improvement is significant which we can find from using FES therapy as well as conventional therapy.

FES can facilitate and improve lower limb function by improving tone, ambulatory function, and muscle efficacy, as well as improve the overall functionality and quality of life and enhance rapid rehabilitation. In a study conducted by Graupe et al. 1998, the use of ES was initially introduced to improve lower extremity function in individuals, especially focusing on foot drop.

Kapadia et al. 2011 conducted a study and showed improvements in grasping, increasing muscular strength, and improving voluntary function. Our study finds improvements in tone, ambulatory function as well as voluntary activity, and muscle power. That also leads to successful rehabilitation.

The Ashworth Grade score of 20 participants was not significantly higher after the intervention. The point ‘ties’ indicate that no patient’s total independence score remained same as the pre-test score. P value is <0.05 which describes that there is less than a 5% chance that the results are due to random error, and it is significant. In experimental group, The Ashworth Grade score of 20 participants was significantly

higher after the intervention. The point ‘ties’ indicate that no Ashworth Grade score remained the same as the pre-test score. P value is <0.05 which describes that there is less than a 5% chance that the results are due to random error, and it is significant. Therefore, it can be said that there has been a significant improvement in muscle tone through interventions.

In control group, The Manual Muscle Testing score of 20 participants was not significant after the 20 sessions of intervention. The point ‘ties’ indicate that no Manual Muscle Testing score remained the same as the pre-test score. P value is not <0.05 and it is not significant. Therefore, it can be said that there is no significant improvement in Muscle Testing Scores through only conventional treatment. In experimental group, The Manual Muscle Testing (MMT) score of 20 participants was significantly higher after the intervention. The point ‘ties’ indicate that no Ashworth Grade score remained the same as the pre-test score. P value is <0.05 which describes that there is less than a 5% chance that the results are due to random error, and it is significant. Therefore, it can be said that there has been a significant improvement in muscle tone through 20 session of Functional Electrical Stimulation (FES) intervention. It can be said that, Functional electrical stimulation as well as conventional therapy have a significance in this approach.

Walking Index Score of 20 participants was not significant after the 20 sessions of intervention. The point ‘ties’ indicate that Walking Index Score remained the same as the pre-test score. The P value is not <0.05 and it is not significant. Therefore, it can be said that there is no significant improvement in Walking Index Score through only conventional treatment. In the experimental group, The Walking Index Score of 20 participants was significant after the 20 sessions of intervention. The point ‘ties’ indicate that no Manual Muscle Testing score remained the same as the pre-test score. The P value is not <0.05 and it is significant. Therefore, it can be said that there is significant improvement in Walking Index Score through only conventional treatment along with electrical stimulation.

P value is significant for the MMT score for n= 40 participants analyzed the by Independent Sample Kruskal Wallis Test and the p-value is <0.05. It denotes significant improvement in MMT score for the hip extensors and knee extensors muscles group.

P value is significant for the Modified Ashworth Grade Score score for n= 40 participants analyzed the by Independent Sample Kruskal Wallis Test and the p-value is <0.05. It denotes significant improvement in MMT score for the hip extensors and knee extensors muscles group.

P value is significant for the WISCI II score for n= 40 participants analyzed the by Independent Sample Kruskal Wallis Test and the p-value is <0.05. It denotes significant improvement in MMT score for the hip extensors and knee extensors muscles group.

Limitations of the study:

The researcher enlisted the assistance of a single data collector, potentially introducing bias into the study. Limited resources, such as the availability of only a Functional Electrical Stimulation (FES) machine, posed challenges. Time constraints further impacted the depth of the study, restricting the scope of data collection to the CRP Savar location exclusively.

Complications, including patient illnesses such as fever and urinary tract infections, disrupted the smooth continuity of therapy sessions. The skill levels among physiotherapists in the Spinal Cord Injury (SCI) unit at CRP varied, potentially influencing the research outcomes. Inconsistencies in scheduling therapy sessions within the CRP setting led to irregularities in treatment adherence among patients. Due to social stigma, the researcher could not convince any female participants. Study should be conducted for both male and female group.

Furthermore, some patients discontinued therapy temporarily for personal reasons, returning to CRP after a hiatus. This discontinuity in therapy sessions added another layer of complexity to the study, affecting the overall consistency of therapeutic interventions

CHAPTER: VI Conclusion and Recommendation

Conclusion

The result of this study showed the Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants. This investigation employed a single-blinded randomized controlled trial design, encompassing a total of 40 participants selected based on predefined inclusion and exclusion criteria. The subjects were randomly allocated into two groups: a control group comprising 20 individuals receiving conventional therapy, and an experimental group of 20 individuals undergoing both conventional therapy and a novel intervention involving functional electrical stimulation—previously unimplemented in the CRP setting alongside conventional therapy. Over the course of 4 weeks, each group underwent a standardized regimen of 20 therapy sessions. After the treatment in both groups found that in control group there is lower significance in MMT score, Modified Ashworth Grade Score and WISCII Score. But in

Recommendation

The result of this study showed the Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants. This investigation employed a single-blinded randomized controlled trial design, encompassing a total of 40 participants selected based on predefined inclusion and exclusion criteria. In future research, this study recommended that to work on this area and finding out relation between exercise and tone. In future studies, it will be recommended to ensure enough tools during the research and to do the double and triple-blinded research. In this study, all physiotherapists who participated in this research were not the same skillful. So, it will be recommended that to focuses in this area in further study this type of research. This study did not focus about muscle strength of upper limb so I will strongly recommend that focuses on the muscle strength of upper limb and find the relation FES and muscle strength.

References

Behrman, AL, Ardolino, EM & Harkema, SJ 2017, "Activity-based therapy: from basic science to clinical application for recovery after spinal cord injury", *Journal of neurologic physical therapy: NPT*,vol. *41*(Suppl 3 IV STEP Spec Iss), ppp.39.

Bhatia, D, Bansal, G, Tewari, RP & Shukla, KK, 2011, 'State of art: functional electrical stimulation (FES)', *International Journal of Biomedical Engineering and Technology*, vol. 5, no. 1, pp.77-99.

Bijak, M, Rakos, M, Hofer, C, Mayr, W, Strohhofer, M, Raschka, D & Kern, H 2005, 'Stimulation parameter optimization for FES supported standing up and walking in SCI patients', *Artificial organs*, vol. 29, no.3, pp. 220-223.

Cheriyan, T, Ryan, DJ, Weinreb, JH, Cheriyan, J, Paul, JC, Lafage, V, Kirsch, T & Errico, TJ 2014, 'Spinal cord injury models: a review', *Spinal cord*,vol. 52 no.8, pp.588-595.

Donaldson, N, Perkins, TA, Fitzwater, R, Wood, DE & Middleton, F, 2000, 'FES cycling may promote recovery of leg function after incomplete spinal cord injury', Spinal Cord, vol. 38, no.11, pp.680-682.

Duffell, LD & Donaldson, NDN 2020, 'A Comparison of FES and SCS for neuroplastic recovery after SCI: historical perspectives and future directions', *Frontiers in neurology*, vol. 11, pp. 607.

Duffell, LD & Donaldson, NDN 2020, 'A comparison of FES and SCS for neuroplastic recovery after SCI: Historical perspectives and future directions', *Frontiers in neurology*, vol. 11, -pp. 607.

Ibitoye, MO, Hamzaid, NA, Hasnan, N, Abdul Wahab, AK & Davis, GM 2016, 'Strategies for rapid muscle fatigue reduction during FES exercise in individuals with spinal cord injury: a systematic review', PloS one, vol. 11, no. 2, pp. 0149024.

Kapadia, NM, Zivanovic, V, Furlan, J, Craven, BC, McGillivray, C & Popovic, MR 2011, 'Functional electrical stimulation therapy for grasping in traumatic incomplete spinal cord injury: randomized control trial', *Artificial organs*, vol. 35, no. 3, pp. 212-216.

McDonald, JW & Sadowsky, C 2002, 'Spinal-cord injury', *The Lancet*, vol. 359 no. 9304, pp. 417-425.

Middleton, JW, Dayton, A, Walsh, J, Rutkowski, SB, Leong, G & Duong, S 2012, 'Life expectancy after spinal cord injury: a 50-year study' *Spinal cord*, vol. 50, no. 11, pp. 803-811.

Nightingale, EJ, Raymond, J, Middleton, JW, Crosbie, J & Davis, GM, 2007, 'Benefits of FES gait in a spinal cord injured population', *Spinal cord*, vol. 45, no. 10, pp. 646-657.

Pang, QM, Deng, KQ, Zhang, M, Wu, XC, Yang, RL, Fu, SP, Lin, FQ, Zhang, Q, Ao, J & Zhang, T 2023, 'Multiple strategies enhance the efficacy of MSCs transplantation for spinal cord injury', *Biomedicine & Pharmacotherapy*, vol. 157, pp.114011.

Pang, QM, Deng, KQ, Zhang, M, Wu, XC, Yang, RL, Fu, SP, Lin, FQ, Zhang, Q, Ao, J & Zhang, T 2023, 'Multiple strategies enhance the efficacy of MSCs transplantation for spinal cord injury', *Biomedicine & Pharmacotherapy*, vol. 157, pp.114011.

Popovic, MR, Keller, T, Papas, IPI, Dietz, V & Morari, M 2001, "Surface-stimulation technology for grasping and walking neuroprostheses", *IEEE Engineering in Medicine and Biology Magazine*, vol. *20 no.*1, pp. 82-93.

Savic, G, DeVivo, MJ, Frankel, HL, Jamous, MA, Soni, BM & Charlifue, S 2017, "Long-term survival after traumatic spinal cord injury: a 70-year British study', *Spinal cord*, vol. *55, no* 7, pp. 651-658.

Sivaramakrishnan, A, Solomon, JM & Manikandan, N 2018, ‘Comparison of transcutaneous electrical nerve stimulation (TENS) and functional electrical stimulation (FES) for spasticity in spinal cord injury-A pilot randomized cross-over trial’, *The journal of spinal cord medicine*, vol. 41, no. 4, pp.397-406.

Taylor, P.N, Burridge, JH, Dunkerley, AL, Wood, DE, Norton, JA, Singleton, C & Swain, ID 1999, “Clinical use of the Odstock dropped foot stimulator: its effect on the speed and effort of walking”, *Archives of physical medicine and rehabilitation*, vol. *80,* no. 12, pp.1577-15

APPENDIX

IRB Permission Letter

Permission Letter

Data collection Permission Letter

Informed consent (English)

Informed consent (Bangla)

Questionnaire (English)

Questionnaire Bangla)

Date: 22th February, 2023
The Chairman
Institutional Review Board (IRB)
Bangladesh Health Professions Institute (BHPI)
CRP-Savar, Dhaka-1343, Bangladesh.

Subject: Application for review and ethical approval.

Dear Sir,

With due respect, I am Maruful Hasan Faruki, student of B.Sc. in physiotherapy program at Bangladesh Health Professions Institute (BHPI) the academic institute of Centre for the Rehabilitation of the Paralysed (CRP) under the Faculty of Medicine, University of Dhaka. As per the course curriculum, I have to conduct a dissertation entitled **"Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Spinal Cord Injury (SCI) participants at a Specialized Rehabilitation Unit"** under the supervision of Ehsanur Rahman, Assistant Professor, Department of Physiotherapy and Rehabilitation, JUST.

The purpose of the study is to explore the effectiveness of FES of knee extensors and hip extensors in paraplegic patients. The study involves FES intervention and face-to-face interview by using semi-structured questionnaire to explore the effectiveness of the device at CRP, Savar, that may take 60 minutes per session. Data collectors will receive informed consent from all participants and the collected data will be kept confidential.

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

Sincerely,

Maruful Hasan Faruki

Maruful Hasan Faruki
4th Year B.Sc. in Physiotherapy
Session: 2017-2018 Student ID: 112170412
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Recommendation from the thesis supervisor

E. Rahman

Ehsanur Rahman
Assistant Professor
Department of Physiotherapy and Rehabilitation, JUST.

Dissertation presentation date: 9th January, 2023

Shofiq 23.02.23

Head, Department of Physiotherapy, BHPI
Md. Shofiqul Islam
Associate Professor & Head
Department of Physiotherapy
Bangladesh Health Professions Institute (BHPI)
CRP, Chapain, Savar, Dhaka-1343

BANGLADESH HEALTH PROFESSIONS INSTITUTE

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

Ref: CRP/BHPI/IRB/03/2023/682

Date: 13/03/2023

To
Maruful Hasan Faruki
B.Sc. in Physiotherapy,
Session: 2017-2018, DU Reg. No: 8620
BHPI, CRP, Savar, Dhaka- 1343, Bangladesh

Subject: Approval of the dissertation proposal **"Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants at a Specialized Rehabilitation Unit"-** by ethics committee.

Dear
Maruful Hasan Faruki,
Congratulations.
The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the above-mentioned dissertation, with yourself, as the Principal Investigator Ehsanur Rahman Robin, Assistant Professor, Department of Physiotherapy & Rehabilitation, JUST. as dissertation supervisor. The following documents have been reviewed and approved:

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

The purpose of the study is to explore the effectiveness of FES of knee extensors and hip extensors in paraplegic patients. Should there any interpretation, typo, spelling, grammatical mistakes in the title, it is the responsibilities of the investigator. Since the study involves questionnaire and intervention that takes maximum 50-60 minutes and have no likelihood of any harm to the participants. The members of the Ethics committee approved the study to be conducted in the presented form at the meeting held at 09:00 AM on January 9, 2023 at BHPI, 34th IRB Meeting.

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

Best regards,

Muhammad Millat Hossain
Associate Professor, Dept. of Rehabilitation Science
Member Secretary, Institutional Review Board (IRB) BHPI,
CRP, Savar, Dhaka-1343, Bangladesh

14th June 2023

The Head of the Physiotherapy Department

CRP, Savar, Dhaka-1343

Subject: Application for seeking permission to collect data for conducting dissertation project.

Through: Head of Physiotherapy Department, BHPI

Sir,

With respect and humble submission to state that I am Maruful Hasan Faruki, a student in 4th-year B.Sc. in physiotherapy at Bangladesh Health Professions Institute (BHPI). The Ethical committee has approved my dissertation project entitled: "Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants at a Specialized Rehabilitation Unit" under the supervision of Ehsanur Rahman, Assistant Professor, Department of Physiotherapy and Rehabilitation, JUST. I have to collect data for my dissertation project from the patient with paraplegia admitted to the spinal cord unit. I would like to assure you that anything in the study will not be harmful to the participants.

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

Sincerely,

Maruful Hasan Faruki

.....

Maruful Hasan Faruki

4th Year B.Sc. in Physiotherapy

Session: 2017-2018 Student ID: 112170412

BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Forwarded
E. Rahman
19.06.23

Approved
16/6/23
Dr. Mohammad Ahsan Habib, PhD
Senior Consultant & Head
Physiotherapy Department
Associate Professor, BHPI
CRP, Savar, Dhaka-1343

Recommended
15-06-2023
Md. Shofiqul Islam
Associate Professor & Head
Department of Physiotherapy
Bangladesh Health Professions Institute (BHPI)
CRP, Chapain, Savar, Dhaka-1343

Informed consent (English)

(Please read out to the participants)

Greetings!

I am Maruful Hasan Faruki, a student of the B.Sc. in Physiotherapy course, Session 2017-2018, at Bangladesh Health Profession Institute, under the Faculty of Medicine, University of Dhaka. I must complete a thesis to earn my B.Sc. in physiotherapy degree. My thesis title is "Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants at a Specialized Rehabilitation Unit". The study aims to find out the Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Participants. In order to ask you some questions about this thesis, I will meet with you twice: once before the intervention and again after completion. I am assuring you that the treatment provided to you will not cause any damage. Besides, physiotherapists will provide the treatments. The information you provide will be kept confidential and will only be used for thesis purposes. You have the right to terminate your participation at any time. Moreover, if you feel uncomfortable answering any question you can skip that question. The questionnaire will take 20 to 30 minutes to fill up. Please give me the correct answers to the questions and enable the data collector to evaluate your health. Contact my supervisor if you have any questions. Ehsanur Rahman, Assistant Professor, Physiotherapy and Rehabilitation Department, JUST. If you would kindly give your consent, we can start.

□ Yes □ No

Thank you for your participation as well as the information.

Participant's signature……. Date…….

Data collector's signature…….. Date……

Researcher's signature…… Date……....

Informed consent (Bangla)

সম্মতিপত্র

(অংশগ্রহণকারীকে পড়ার জন্য অনুরোধ করা হলো)

আসসালামুআলাইকুম, আমি মারুফুল হাসান ফারুকী। ঢাকা বিশ্ববিদ্যালয়ের চিকিৎসা অনুষদের অধীনে বাংলাদেশ হেলথ প্রফেশনস ইন্সটিটিউট (বি এইচ পি আই) এর ফিজিওথেরাপি কোর্সের ২০১৭-১৮ সেশনের শিক্ষার্থী। আমার বিএসসি ইন ফিজিওথেরাপি ডিগ্রী অর্জনের জন্য আমাকে একটি গবেষনা সম্পুর্ন করতে হবে।আমার গবেষনার শিরোনাম হল, "**মেরুরজ্জুতে আঘাতপ্রাপ্ত রোগিদের মাংসপেশির উপর তড়িৎ উদ্দীপনার প্রভাব**"। এই গবেষনা সম্পুর্ন করার জন্য আমি আপনাকে আপনার শারিরীক অবস্থা সম্পর্কিত কিছু প্রশ্ন করব । আপনাকে আশ্বস্ত করছি, আমার ও আমার প্রশ্নের দ্বারা আপনার কোনরূপ ক্ষতি হবে না। আপনার দেওয়া তথ্য গোপন রাখা হবে এবং শুধুমাত্র গবেষনার উদ্দ্যেশ্যে ব্যাবহার করা হবে। যে কোন সময় গবেষনায় আপনার অংশগ্রহন বন্ধ করার অধিকার রয়েছে। পাশাপাশি আপনি যদি কোন প্রশ্নের উত্তর দিতে অশ্বস্তি বোধ করেন তবে আপনি সেই প্রশ্ন এড়িয়ে যেতে পারেন। প্রশ্নাবলী পূরন করতে ৩০ মিনিট থেকে ৪০ মিনিট সময় লাগবে। অনুগ্রহ করে আমার প্রশ্নাবলীর সঠিক উত্তর দিন এবং আপনার স্বাস্থ্যের মুল্যয়ন করতে ডেটা সংগ্রহকারীকে যথাসাধ্য সহযোগীতা করুন। আপনার কোন প্রশ্ন থাকলে আমার সুপারভাইজারের সাথে যোগাযোগ করতে পারেন, এহসানুর রহমান, এসিসট্যান্ট প্রফেসর, ফিজিওথেরাপি এবং রিহ্যাবিলিটেশন বিভাগ, যশোর বিজ্ঞান ও প্রযুক্তি বিশ্ববিদ্যালয়। আপনি যদি অনুগ্রহ পুর্বক আপনার সম্মতি দেন, তাহলে আমরা শুরু করতে পারি।

হ্যা না

ধন্যবাদ আপনার অংশগ্রহনের পাশাপাশি প্রশ্নগুলোর যথাযথ উত্তর দিয়ে সহযোগিতা করার জন্য।

অংশগ্রহনকারীর স্বাক্ষর..... তারিখ.....

তথ্য সংগ্রহকারীর স্বাক্ষর..... তারিখ.....

গবেষকের স্বাক্ষর..... তারিখ.....

Questionnaires English

Research Title: **"Effectiveness of Functional Electrical Stimulation (FES) of Knee Extensors and Hip Extensors in Paraplegic Spinal Cord Injury (SCI) Participants at a Specialized Rehabilitation Unit"**

Date:

Patient ID No: Patient's Mobile No:

Caregiver: Caregiver Mobile No:

Part I: Socio-demographic information

<table>
<tr><td>Question</td><td colspan="2">Patient Response</td></tr>
<tr><td>1. Age (Years)</td><td colspan="2"></td></tr>
<tr><td>2. Gender</td><td colspan="2">1. Male 2. Female</td></tr>
<tr><td>3. Education Level</td><td colspan="2">1.No formal education 2. Primary
3. Secondary 4. Higher Secondary 5. Graduate
6. Post Graduate</td></tr>
<tr><td rowspan="2">4. Occupation/ Profession:</td><td>Before SCI</td><td>After SCI</td></tr>
<tr><td>• Shopkeeper = 2
• Farmer = 3
• Service holder = 4
• Business = 5
• Day-labor = 6
• Student = 7
• Unemployed = 8
• Others = 9</td><td>• Housewife = 1
• Shopkeeper = 2
• Farmer = 3
• Service holder = 4
• Business = 5
• Day-labor = 6
• Student = 7
• Unemployed = 8
• Others = 9</td></tr>
<tr><td>5. Address:</td><td colspan="2">1. Union: _____
2. Ward no. _____
3. Village: _____
4. House no:</td></tr>
<tr><td>6. Marital status:</td><td colspan="2">1. Married 2. Unmarried 3. Divorced 4. Separated</td></tr>
<tr><td>7. Number of Family member:</td><td colspan="2"></td></tr>
<tr><td>8. Number of adult members
in the family (Above 18 years)</td><td colspan="2"></td></tr>
<tr><td>9. Number of earning members</td><td colspan="2"></td></tr>
<tr><td>10. Financial condition:</td><td colspan="2"></td></tr>
<tr><td>11. Family income (monthly)</td><td colspan="2"></td></tr>
<tr><td>11. Family income (monthly)</td><td colspan="2"></td></tr>
</table>

12. Treatment expense:	

Part II: Clinical information

13. Date of incidence:	_ _ / _ _ / _ _ _ _
14. Health care:	1. Hospital 2. Thana health complex 3. Private Clinic 4. Home
15. Name of the facility	1. NINS (neuroscience hospital) 2. CRP 3. NITOR (Orthopedic hospital) 4. Home 5. Others (name) _____
16. Admission Date (if yes):	
17. Discharge Date (if yes):	
18. Causes of Paralysis	1. Traumatic 2. Non-traumatic

Part-III: Spinal cord injury questionnaire:

19. Causes of injury:	1. Fall from height 2. Road traffic accident 3. Fall heavy object on the head 4. Scarf injury 5. Physical assault 6. Bull attack 7. Bullet injury 8. Spinal Tumor 9. Other	
20. Diagnosis	1. Traumatic paraplegia 2. Non-traumatic tetraplegia	
21. Treatment Received:	1. Conservative 2. Surgery 3. Surgery & conservative	
22. Comorbidity (You can choose multiple responses)	**Before SCI**	**After SCI**
	1. heart diseases 2. High blood pressure 3. respiratory diseases 4. Diabetes 5. Ulcer and stomach disease 6. kidney disease 7. Liver disease	1. Pressure sore 2. Depression 3. Bowel bladder dysfunction 4. Respiratory complications 5. Depression 6. Postural hypotension 7. Urinary incontinence 8. Circulatory problem 9. Spasticity

	8. Anemia or other blood diseases	10. Autonomic dysreflexia

Part- IV: Clinical Examination

(A) Tone in Modified Ashworth Scale:

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

B) Muscle Testing of major key muscles

0	No palpable contraction
1	Visible or palpable contraction but unable to move
1+	Able to move through a small range (<50%) with gravity eliminated
2-	Able to move through a large range (= or > 50%) with gravity eliminated
2	Able to move through full range (= 100%) with gravity eliminated
2+	Able to move through a small range (<50%) against gravity
3-	Able to move through a large range (= or > 50%) against gravity
3	Able to move through full range (= 100%) against gravity
3+	Able to move through full range (= 100%) against gravity with small resistance through a small range (<50%)
4-	Able to move through full range (= 100%) against gravity with small resistance through full range (= 100%)
4	Able to move through full range (= 100%) against gravity with moderate resistance through full range (= 100%)
4+	Able to move through full range (= 100%) against gravity with maximal resistance through range (< 100%)
5	Normal strength

Key Muscles:

Muscles group	**Right Side**	**Left Side**
Hamstring		
Quadriceps		
Gluteus		

(D) Scoring Sheet for the Walking Index for Spinal Cord Injury II (WISCI II)

Level	Description
0	Client is unable to stand and/or participate in assisted walking.
1	Ambulates in parallel bars, with braces and physical assistance of two persons, less than 10 meters
2	Ambulates in parallel bars, with braces and physical assistance of two persons, 10 meters.
3	Ambulates in parallel bars, with braces and physical assistance of one person, 10 meters.
4	Ambulates in parallel bars, no braces and physical assistance of one person, 10 meters
5	Ambulates in parallel bars, with no braces and no physical assistance, 10 meters.
6	Ambulates with walker, with braces and physical assistance of one person, 10 meters.
7	Ambulates with two crutches, with braces and physical assistance of one person, 10 meters.
8	Ambulates with walker, no braces and physical assistance of one person, 10 meters.
9	Ambulates with walker, with braces and no physical assistance, 10 meters.
10	Ambulates with one cane/crutch, with braces and physical assistance of one person, 10 meters.
11	Ambulates with two crutches, no braces and physical assistance of one person, 10 meters.
12	Ambulates with two crutches, with braces and no physical assistance, 10 meters.
13	Ambulates with walker, no braces and no physical assistance, 10 meters.
14	Ambulates with one cane/crutch, no braces and physical assistance of one person, 10 meters.
15	Ambulates with one cane/crutch, with braces and no physical assistance, 10 meters.
16	Ambulates with two crutches, no braces and no physical assistance, 10 meters.
17	Ambulates with on devices, no braces and physical assistance of one person, 10 meters.
18	Ambulates with on devices, with braces and no physical assistance, 10 meters.
19	Ambulates with one cane/crutch, no braces and no physical assistance, 10 meters.
20	Ambulates with no devices, no braces and no physical assistance, 10 meters.

প্রশ্নপত্র

গবেষণার শিরোনামঃ "মেরুরজ্জুতে আঘাতপ্রাপ্ত রোগিদের মাংসপেশির উপর তড়িৎ উদ্দীপনার প্রভাব"

তারিখঃ

আইডি নাম্বারঃ মোবাইল নাম্বারঃ

পরিচর্যাকারীঃ পরিচর্যাকারীর মোবাইল নাম্বারঃ

১ম অংশঃ <u>সামাজিক-জনতাত্ত্বিক তথ্য</u>

<table>
<tr><th>প্রশ্ন</th><th colspan="2">প্রতিক্রিয়া</th></tr>
<tr><td>১। বয়স</td><td colspan="2"></td></tr>
<tr><td>২। লিঙ্গ</td><td colspan="2">১। পুরুষ ২। মহিলা</td></tr>
<tr><td>৩। পড়াশুনার ধরণ</td><td colspan="2">১। নিরক্ষর ২। প্রথমিক
৩। মাধ্যমিক ৪। উচ্চ মাধ্যমিক ৫। স্নাতক ৬। স্নাতকোত্তর</td></tr>
<tr><td rowspan="2">৪। পেশা</td><td>ইনজুরির আগে</td><td>ইনজুরির পরে</td></tr>
<tr><td>• গৃহীণী= ১
• দোকানদার = ২
• কৃষক = ৩
• চাকুরীজীবী= ৪
• ব্যাবসা= ৫
• দিনমজুর= ৬
• ছাত্র= ৭
• বেকার= ৮
• অন্যান্য= ৯</td><td>• গৃহীণী= ১
• দোকানদার = ২
• কৃষক = ৩
• চাকুরীজীবী= ৪
• ব্যাবসা= ৫
• দিনমজুর= ৬
• ছাত্র= ৭
• বেকার= ৮
• অন্যান্য= ৯</td></tr>
<tr><td>৫। ঠিকানা</td><td colspan="2">১। ইউনিয়ন _____
২। ওয়ার্ড_____
3. গ্রাম _____</td></tr>
<tr><td>৬। বৈবাহিক অবস্থা</td><td colspan="2">১। অবিবাহিত ২। বিবাহিত ৩। আলাদা ৪। তালাকপ্রাপ্ত</td></tr>
<tr><td>৭।পরিবারের সদস্য সংখ্যা</td><td colspan="2"></td></tr>
<tr><td>৮। প্রাপ্তবয়স্ক সদস্য সংখ্যা</td><td colspan="2"></td></tr>
<tr><td>৯। উপার্জনক্ষম সদস্য সংখ্যা</td><td colspan="2"></td></tr>
<tr><td>১০। আর্থিক অবস্থা</td><td colspan="2">১। স্বনির্ভর ২। পরনির্ভর</td></tr>
<tr><td>১১। মাসিক আয়</td><td colspan="2"></td></tr>
<tr><td>১২। পরিবারের আয়</td><td colspan="2"></td></tr>
</table>

১৩। চিকিতস্যার খরচ	

২য় অংশঃ ক্লিনিকাল তথ্য

১৪। ঘটনার তারিখ	__/__/____
১৫। স্বাস্থ্য সেবা	১। হাসপাতাল ২। হাসপাতাল ৪। প্রাইভেট ক্লিনিক ৪। বাড়ি
১৬। সুবিধা	১। নিউরোসায়েন্স ২। সি আর পি ৩। নিটোর ৪। বাড়ি ৫। অন্যান্য _____
১৭। ভর্তির তথ্যঃ	
১৮। ছাড়ের তথ্যঃ	
১৯। প্যারালাইসিসের কারণ	১। আঘাত ২। আঘাতজনক নয়

৩য় অংশঃ মেরুরজ্জুর ইনজুরির প্রশ্নপত্র

২০। ইনজুরির কারণ	১। উচ্চতা থেকে পড়া ২। সড়ক যানবাহন দুর্ঘটনা ৩। ভারী বস্তু মাথায় পড়া ৪। ওড়না দ্বারা ইনজুরি ৫। শারীরিক হামলা ৬। ষাড়ের হামলা ৭। গুলির আঘাত ৮। মেরুদণ্ডের টিউমার ৯। অন্যান্য	
২০। নীর্ণীত রোগ	১। আঘাতজনিত প্যারাপ্লেজিয়া ২। রোগজনিত প্যারাপ্লেজিয়া	
২১। গৃহীত চিকিতস্যা	১। ফিজিওথেরাপি ২। অস্ত্রোপচার ৩। অস্ত্রোপচার ও ফিজিওথেরাপি	
২২। সহ-অসুখ	**ইনজুরির আগে**	**ইনজুরির পরে**
	১। হৃদযন্ত্রের রোগ ২। উচ্চ রক্ত চাপ ৩। শ্বাসযন্ত্রের রোগ ৪। ডায়াবিটিস ৫। আলসার ও পাকস্থলির রোগ ৬। কিডনির রোগ ৭। যকৃতের রোগ ৮। রক্তশূন্যতা	১। চাপজনিত ক্ষত ২। বিষন্নতা ৩। মল ও পিছলি প্রণালী দোষ ৪। শ্বাসযন্ত্রের জটিলতা ৫। অবস্থানিক নিম্নতা ৬। প্রস্রাবের জ্বালাপোড়া ৭। চক্রবর্তী দোষ ৮। স্প্যাস্টিসিটি ৯। অটনমিক ডিসরেফ্লেকসিয়া

৪ র্থ অংশ : ক্লিনিক্যাল পরীক্ষা

ক) মডিফাইড এশওয়ার্থ গ্রেড স্কেলে টোন পরীক্ষা

গ্রেড	বর্ননা
০	মাংসপেশির টোনে কোন বৃদ্ধি হয়নি
১	মাংসপেশির টোনে সামান্য বৃদ্ধি, যা আঘাত এবং মুক্তিতে বা আক্রমণ স্থানের শেষে কম প্রতিরোধের সাথে প্রকাশ হয়, যখন আক্রান্ত অংশটি(গুলি)কে মোশনে ফ্লেকশন বা এক্সটেনশনে চলানো হয়
১+	মাংসপেশির টোনে সামান্য বৃদ্ধি, যা একটি আঘাতে প্রকাশিত হয়, এরপর, সামান্য প্রতিরোধ অনুভূত হয় (অধিকাংশের চেয়ে কম হয়ে)।
২	অঙ্গের মুভমেন্টের অধিকাংশে মাংসপেশির টোনে আরও সোজা বৃদ্ধি, তবে আক্রান্ত অংশ(গুলি) সহজে চলানো যায়।"
৩	মাংসপেশির টোনে বৃদ্ধি, প্যাসিভ নড়াচড়া কঠিন।"
৪	"আক্রান্ত অংশ(গুলি) ফ্লেকশন বা এক্সটেনশন শক্ত হয়ে যাবে

খ) প্রধান মূল মাংসপেশির শক্তি পরীক্ষা"

০	অনুভূত সংকোচন নেই
১	দৃশ্যমান বা অনুভূত সংকোচন থাকলেও চলাতে অসমর্থ
১+	গ্রাভিটি অপসারণ করে একটি ছোট পরিসীমা (<৫০%) মোতাবেক চলানো সম্ভব
২-	গ্রাভিটি অপসারণ করে একটি বড় পরিসীমা (= অথবা > ৫০%) মোতাবেক চলানো সম্ভব
২	গ্রাভিটি অপসারণ করে একটি পূর্ণ পরিসীমা (= ১০০%) মোতাবেক চলানো সম্ভব
২+	গ্রাভিটির বিরুদ্ধে একটি ছোট পরিসীমা (<৫০%) মোতাবেক চলানো সম্ভব
৩-	গ্রাভিটির বিরুদ্ধে একটি বড় পরিসীমা (= অথবা > ৫০%) মোতাবেক চলানো সম্ভব
৩	গ্রাভিটির বিরুদ্ধে একটি পূর্ণ পরিসীমা (= 100%) মোতাবেক চলানো সম্ভব"
৩+	গ্রাভিটির বিরুদ্ধে একটি পূর্ণ পরিসীমা (= 100%) মোতাবেক ছোট প্রতিরোধ সহিত একটি ছোট পরিসীমা (<50%) মোতাবেক চলানো সম্ভব"
৪-	গ্রাভিটির বিরুদ্ধে একটি পূর্ণ পরিসীমা (= 100%) মোতাবেক পূর্ণ পরিসীমা (= 100%) সহিত ছোট প্রতিরোধ চলানো সম্ভব"
৪	গ্রাভিটির বিরুদ্ধে একটি পূর্ণ পরিসীমা (= 100%) মোতাবেক মধ্যম প্রতিরোধ সহিত পূর্ণ পরিসীমা (= 100%) চলানো সম্ভব
৪+	গ্রাভিটির বিরুদ্ধে একটি পূর্ণ পরিসীমা (= 100%) মোতাবেক সর্বাধিক প্রতিরোধ সহিত একটি পরিসীমা (< 100%) চলানো সম্ভব"
৫	সাধারণ শক্তি

গ) প্রধান মাংসপেশি

মাংসপেশির গ্রুপ	**ডান পাশ**	**বাম পাশ**
হ্যামস্ট্রিং		
কুয়াড্রিসেপস		
গ্লুটিয়াস		

ঘ) মেরুরজ্জুতে আঘাতপ্রাপ্তদের জন্য ওয়াকিং ইনডেক্স স্কোর

লেভেল	বর্ণনা
০	ক্লায়েন্ট দাঁড়াতে অসমর্থ এবং/অথবা সাহায্যে হাঁটাতে অংশগ্রহণ করতে পারেন না
১	প্যারালেল বারে হেঁটে চলে, ব্রেস এবং দুই জনের শারীরিক সাহায্যে, ১০ মিটারের কম দূরত্বে
২	প্যারালেল বারে হেঁটে চলে, ব্রেস এবং দুই জনের শারীরিক সাহায্যে, ১০ মিটার দূরত্বে.
৩	প্যারালেল বারে হেঁটে চলে, ব্রেস এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার দূরত্বে
৪	প্যারালেল বারে হেঁটে চলে, কোন ব্রেস নেই এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার দূরত্বে
৫	প্যারালেল বারে হেঁটে চলে, কোন ব্রেস এবং কোন শারীরিক সাহায্য ছাড়া, ১০ মিটার দূরত্বে.
৬	ওয়াকার সঙ্গে হেঁটে চলে, ব্রেস এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার
৭	দুটি ক্রাচ নিয়ে হেঁটে চলে, ব্রেস এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার
৮	ওয়াকার সঙ্গে হেঁটে চলে, কোন ব্রেস নয়, এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার
৯	ওয়াকার সঙ্গে হেঁটে চলে, ব্রেস সহিত এবং কোন শারীরিক সাহায্য ছাড়া, ১০ মিটার
১০	একটি লাঠি/ক্রাচ সঙ্গে হেঁটে চলে, ব্রেস এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার
১১	দুটি ক্রাচ সঙ্গে হেঁটে চলে, কোন ব্রেস নয়, এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার
১২	দুটি ক্রাচ সঙ্গে হেঁটে চলে, ব্রেস সহিত এবং কোন শারীরিক সাহায্য ছাড়া, ১০ মিটার
১৩	ওয়াকার সঙ্গে হেঁটে চলে, কোন ব্রেস নয়, এবং কোন শারীরিক সাহায্য ছাড়া, ১০ মিটার
১৪	একটি কেন/ক্রাচ সঙ্গে হেঁটে চলে, কোন ব্রেস নয়, এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার
১৫	একটি কেন/ক্রাচ সঙ্গে হেঁটে চলে, ব্রেস সহিত এবং কোন শারীরিক সাহায্য ছাড়া, ১০ মিটার
১৬	দুটি ক্রাচ সঙ্গে হেঁটে চলে, কোন ব্রেস নয় এবং কোন শারীরিক সাহায্য নেই, ১০ মিটার
১৭	কোন ডিভাইস সঙ্গে হেঁটে চলে, কোন ব্রেস নয় এবং এক জনের শারীরিক সাহায্যে, ১০ মিটার
১৮	কোন ডিভাইস সঙ্গে হেঁটে চলে, ব্রেস সহিত এবং কোন শারীরিক সাহায্য নেই, ১০ মিটার
১৯	একটি কেন/ক্রাচ সঙ্গে হেঁটে চলে, কোন ব্রেস নয় এবং কোন শারীরিক সাহায্য নেই, ১০ মিটার
২০	কোন ডিভাইস ছাড়া হেঁটে চলে, কোন ব্রেস নয় এবং কোন শারীরিক সাহায্য নেই, ১০ মিটার