Faculty of Medicine

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EFFECTIVENESS OF CORE STABILIZATION EXERCISES FOR FUNCTIONAL IMPROVEMENT OF SPINAL CORD INJURY (SCI) PATIENTS

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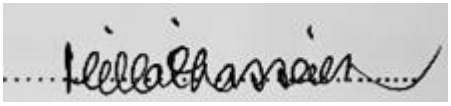
We underdesigned certify that we have carefully read and recommended to the Faculty of Medicine, University of Dhaka, for the acceptance of this dissertation entitled.

EFFECTIVENESS OF CORE STABILIZATION EXERCISES FOR FUNCTIONAL IMPROVEMENT OF SPINAL CORD INJURY (SCI) PATIENTS

Submitted by **Mahdi Ul Bari** for partial fulfillment of the requirements for the degree of Bachelor of Science in Physiotherapy (B. Sc. PT).



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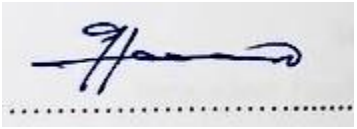

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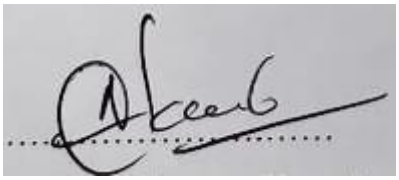

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Declaration

I hereby declare that the present dissertation entitled **'Effectiveness of Core Stabilization Exercises for Functional Improvement of Spinal Cord Injury (SCI) Patients'** is an original work of my own. All sources used have been cited appropriately. Any mistakes or inaccuracies are my own. I also declare that for any publication, presentation, or dissemination of the study. I would be bound to take written consent from the Department of Physiotherapy, Bangladesh Health Professions Institute (BHPI).

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Acronyms

SCI	Spinal Cord Injury
RTA	Road Traffic Accident
ASIA	American Spinal Injury Association
AIS	ASIA Impairment Scale
EMG	Electromyography
Qol	Quality of Life
tSCS	Transcutaneous electrical spinal cord stimulation

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Abstract

Spinal cord injury (SCI) is a destructive damage to the spinal cord that affect the motor and sensory functions as well as frequently representing itself as a long-term medical condition that require a sophisticated management and rehabilitation plan. **Purpose:** The aim of this study is to determine the effectiveness of core stability exercises in functional improvement of SCI patients. **Objective:** To explore the effectiveness of core stability exercises in functional improvement of SCI patients, that will include self-care, respiratory and sphincter management, and mobility (room and toilet). **Methodology:** The study was a Quasi Experimental study design that measured pre-test and post-test results. 28 patients were allocated based on inclusion criteria. The age range was 18-78 years. The participants received daily sessions for 5 days/week for 4 weeks. American Spinal Injury Association (ASIA) Impairment Scale was used to measure the SCI level. Spinal Cord Impairment Measure version 3 (SCIM-3) was used to measure the functional independence of SCI patients, that has three sub-scales including self-care, respiratory and sphincter management, and mobility (room and toilet). **Results:** The pre and post test results of 28 participants were measured using Wilcoxon Signed ranked test. The test reveals that the total functional independence score statistically improved ($p<0.05$) after receiving the intervention. Self-care and mobility (room and toilet) score improved ($p<0.05$) significantly but respiration and sphincter management function did not show a significant difference ($p=0.205$) when analyzed respectively. **Conclusion:** The study showed that core stability exercises improve functional independence in patients with an incomplete SCI. Among the measured functional activities, self-care, and mobility (room and toilet) activities were improved but respiratory and sphincter activities did not improve after the intervention.

Keywords: *Spinal cord injury, functional independence, core stability exercises*

CHAPTER-I: INTRODUCTION

1.1 Background

A complex network of upper and lower motor neurons makes up the human spinal cord, which serves as a bidirectional connection between the brain and its motor, sensory, and autonomic functions. Additionally, it works as a hub for the integration of reflexes between the motor and autonomic mechanisms of body receptors (Emos and Agarwal 2022, p. 1).

Spinal cord injury (SCI) is a destructive damage to the spinal cord that affect the motor and sensory functions as well as frequently representing itself as a long-term medical condition that require a sophisticated medical facility (Fouad et al. 2021, pp. 1).

Paralysis is the most evident effect of spinal cord injury. SCI, however, also has widespread effects on a variety of bodily processes, such as intestinal, respiratory, cardiovascular, and sexual function. Additionally, it has social, financial, and psychological repercussions and makes people more vulnerable to musculoskeletal injuries, discomfort, osteoporosis, and other issues as well as late-life renal difficulties (Harvey 2016, pp. 4-6).

In recent years, SCI has been describing as a structure-function paradox. It describes the unpredictability of an affected person's syndromes by observing the anatomical and radiological findings. An example to that is that about 25% people categorized complete A by American Spinal injury Association Impairment Scale (AIS) will convert to incomplete SCI within the first year after injury (Fouad et al. 2021, pp. 1-2).

Functional impairment tends to be the result of impaired limb activities, alternation in trunk and pelvis control as well as altered sensation. Trunk injuries are closely related to a reduction of functional independence which is essential for daily life activities such as mobility and self-care. So, exercises that mainly subject to improve trunk stability and motor relearning by means of strengthening the trunk muscles. Strengthened trunk muscles

frequently lead to better balance and control over the injured muscles, which support functional independence (Cabanas Valdés et al. 2021, p. 2).

The stability of the core or lumbopelvic region is crucial to provide foundation for the limb activities to support weight bearing and stabilizing the spine. The concept of core strengthening has evolved to core stabilization in recent years. Subjecting strengthening of the trunk muscles as one of the components for stabilization exercises, it aims towards improving the dynamic balance of the trunk and the load bearing capacity of the spine. Core stabilization exercises greatly helps to reduce spinal dysfunctional syndromes and helps the patient towards an optimized functionality (Cowan, Crossley and Bennell 2009, pp. 584-586).

The contraction of the spine in all possible forms of instability is a crucial function of the spine's musculature. It is possible to actively regulate spinal stability by adjusting the force produced by the muscles around it. During every dynamic movement, the trunk's extensor, flexor, and lateral flexor group of muscles maintain spinal stability. Core stability plays a critical role in integrated activities, where multiple muscle groups and joints work together in a coordinated manner. Whether it's a sport-specific skill, functional movement, or even daily tasks like bending and lifting, a stable core is essential for optimal performance and injury prevention. So, there is an important need to have balanced function of active and passive control over trunk muscles (Kakade and Kanase 2020, p. 986)

The spine stability system mainly consists of three subsystems: passive spinal column, active spinal muscles, and neural control unit. Any alterations to one of these components compromise the stability of the spine. Core stability facilitates the efficient transfer of force from the core to the limbs or terminal segments (e.g., arms, and legs). The passive subsystem of the spine includes the bones (vertebrae) and the intervertebral discs. These structures provide structural support and stability to the spine. They are the foundation upon which the other subsystems operate. The active subsystem, often referred to as the "core," consists of a group of muscles that play a crucial role in stabilizing the spine. These muscles work together to provide dynamic stability, support, and control during various

activities. The core muscles include abdominals in the front, paraspinals and gluteal in the back, the diaphragm serving as the roof, and lastly pelvic floor and hip musculature at the bottom. These muscles have a direct or indirect attachment with the spine thus it is making up an active subsystem for balance, co-ordination, and control of the spine (Cowan, Crossley and Bennell 2009, pp. 585-586).

Core stability describes the ability to control the position and movement of the central portion of the body to allow optimum production, transfer and control of force and motion to the terminal segments in the integrated activities. A stable core provides a solid foundation for generating force in movements such as lifting, pushing, pulling, or twisting. It allows the transfer of force from the lower body to the upper body and vice versa, which is crucial in activities like weightlifting, sports, and daily tasks. (Kakade and Kanase 2020, p. 986).

In summary, core stability is a foundational element in human movement and physical performance. It ensures that the central portion of the body can efficiently produce, transfer, and control force and motion, enhancing overall functional abilities and reducing the risk of injuries, particularly in the lower back and trunk regions. As a result, core training is a fundamental component of many fitness and rehabilitation programs.

PT therapies may address the goal of rehabilitation, which is increased participation and consequently improved overall quality of life, by lowering activity limits. Modern SCI patients are experiencing longer lifespans and increased levels of functional independence because of advancements in medical, rehabilitative, technological, and pharmaceutical treatment of their condition. Physical therapy (PT) interventions potentially have targets across all three functioning domains targeting to modify specific body impairments such as strength, cardiovascular fitness, joint mobility, muscle extensibility, bone loss, pain, and spasticity (Gómara Toldrà et al. 2014, pp. 371-372).

1.2 Rationale

The prime purpose of this study is to find out if core stability exercises along with conventional physiotherapy can improve a spinal cord injured patient's functionality in terms of respiration, mobility, and self-care activities. SCI is a devastating condition that affects an individual both physically and mentally. SCI causes a great barrier in carrying out normal functionality of the human body. One of the common effects of SCI is difficulty breathing, decreased bowel and bladder control, and a lack of movement and capacity to conduct transfers. Therefore, it is crucial to enhance these deficiencies. Another most severely impacted structure by the mechanism of spinal cord damage is the core musculature. The core muscles of the body act as a power storage for providing energy to carry out various functionality of our body. Strength training has already been shown to enhance a variety of human functions. A set of core stability exercises may be useful for enhancing a patient's functionality because strength is one of the components of stability. Traditional core strengthening exercises can overload an already injured spine and can deteriorate a patient's condition. Core stabilization exercises play a dynamic role in providing dynamic stabilization to the spine without overloading it and can minimize the impact of spinal dysfunctional syndromes.

The exercises that are included in this study are all active exercises. So patients can carry out these exercises even after discharge. These exercises are easy to perform and has a very low chance of worsening their condition. Performing these exercises requires low monitoring of a specialist. Patients can achieve spinal stability by performing these exercises irrespective of their socio-economic condition including very low economic class.

A single core muscle group has been the subject of certain studies to evaluate the impact of their strengthening. The effects of numerous therapies on multiple aspects of functional rehabilitation after SCI have been examined. I wish to present a series of core stability exercises and evaluate their efficacy in enhancing a spinal cord injured person's independence in self-care, breathing, and mobility.

1.3 Aim

The aim of this study is to determine the effectiveness of core stability exercises in functional (self-care, respiratory and sphincter management, and mobility) improvement of SCI patients.

1.4 Objective

1.4.1 General objective

To explore the effectiveness of core stability exercises in functional improvement of SCI patients.

1.4.2 Specific objectives

1. To explore the effectiveness of exercise programs in self-care.
2. To explore the effectiveness of exercise program respiration.
3. To determine the effectiveness of exercise programs in mobility independence.
4. To explore the socio-demographic status of the participants

1.5 Hypothesis

1.5.1 Null Hypothesis (H_0)

Core stabilization exercises along with conventional physiotherapy is no more effective than conventional physiotherapy only to improve the functional independence of SCI patients.

H_0: $\mu_1 - \mu_2 = 0$ or $\mu_1 = \mu_2$, where the pretest and posttest group, initial and final mean difference is same.

1.5.2 Alternative hypothesis (H_1)

Core stabilization exercises along with conventional physiotherapy is more effective than conventional physiotherapy only to improve the functional independence of SCI patients.

H_1: $\mu_1 - \mu_2 \neq 0$ or $\mu_1 \neq \mu_2$, where the pretest and posttest group, initial and final mean difference is not same.

1.6 Operational definition

Spinal Cord Injury

A complete or incomplete injury to the spinal cord which can be either traumatic or non-traumatic is defined as spinal cord injury (SCI).

Incomplete C

It describes that the impairment is incomplete with preservation of motor function below the neurologic level but more than half of the key muscles below the neurologic level have a muscle grade less than grade 3.

Incomplete D

It describes that the impairment is incomplete with preservation of motor function below the neurologic level but more at least half of the key muscles below the neurologic level have a muscle grade of 3 or more.

Core stability

Core stability describes the ability to control the position and movement of the central portion of the body to allow optimum production, transfer and control of force and motion to the terminal segments in the integrated activities.

Effectiveness

The capability of producing desired result. When something is deemed effective, it means it has an intended expected outcome, or produces a deep, vivid impression.

CHAPTER-II: LITERATURE REVIEW

Whether caused by trauma or not, spinal cord injury (SCI) is a sudden, fatal, and paralyzing neurological disorder discussed throughout history. Damage to the spinal cord can lead to various degrees of paralysis and loss of sensory and motor function. Historically, there has been a male predominance in SCI cases. Men have traditionally engaged in riskier activities and occupations that put them at higher risk of injury. However, it's important to note that SCI can affect individuals of any gender. A prevalence of 15–40 occurrences per million annually, and a tendency to impact the low-socioeconomic group, spinal cord injuries are on the rise. The cost of medical care, rehabilitation, and ongoing support for individuals with SCI can be significant. Furthermore, those with lower socioeconomic status may face additional challenges in accessing the necessary care and resources (Rahman et al. 2017, p. 1).

According to Hoque et al. (2012, pp. 275-277), falling from a height account for 63% of SCI in Bangladesh. Another frequent reason for tetraplegia in Bangladesh (8%), is falling while carrying a heavy load on the head. Both the incidence and prevalence of SCI are steadily rising globally.

National Institute of Neurological Disorders and Stroke (2023, pp. 1-4) reports several complications that may arise following a spinal cord injury. As the nerves in this area control the movement of the diaphragm and the expansion of the lungs, any lesion to the spinal cord between the C1-C4 segments can cease breathing and resolution to that often requires short- or long-term use of breathing tubes. Urination becomes abnormal without spinal coordination because the muscles in the bladder and urethra can't cooperate with the brain efficiently. Other complications include pressure sore, pneumonia, increased tone, pain, sexual dysfunctions, and depression. These complications require long standing rehabilitation plans that are sometimes considered as a burden for families with poor socio-economic status. More than 80% of spinal cord injury patients are men, and 55% of them are between the ages of 16 and 30. As spinal cord injuries require extensive rehabilitation, they may be a strain on the community, society, and the nation.

Falls (both simple falls and falls from great heights), RTA, sports-related accidents, violence, and other causes of injury are only among some of the many factors that contribute to SCI. The incidence of SCI grew gradually with the development of human activities. In industrialized countries, the incidence rates varied from 13.121 to 163.420 per million persons. Undeveloped countries rates ranged from 13.019 to 220.022 per million people (Kang et al. 2018, p. 2).

Due to the difficulties of living with the condition and the differences in how people experience it around the world, such as the effect that someone with SCI will have on the standard of care they receive, SCI has more significant implications for managing health care. To seek help from all clinical facilities that his or her country provides, including those for emergency treatment, intensive care, surgery, stabilizing medical care, and rehabilitation, which includes returning to the community, vocational rehabilitation, and continued primary care. Additionally, it assists physicians, healthcare workers, researchers, and decision-makers in comprehending the benefits and drawbacks of their nation's healthcare system. (WHO 2013, pp. 1-3).

Paralysis is the most evident effect of spinal cord injury (SCI). SCI, however, also has widespread effects on a variety of bodily processes, such as intestinal, respiratory, cardiovascular, and sexual function (Harvey 2016, p. 2).

A survey was done by Strom et al. (2022, pp. 4-8) on the arising physical complications across 21 countries. They found that having pain, muscle spasms/spasticity, sexual dysfunction and bowel dysfunction were the most common, all with rates above 70%. Overall, 95.8% of the participants reported experiencing 1 or more health problems secondary to their SCI within 3 months of spinal injury. Experiencing pain in day-to-day life was the most prevalent self-reported health condition.

Damage to the spinal cord is only one of several effects of a spinal cord injury (SCI). Both the lives of those who care for them and those of persons who suffer from SCI are

profoundly and permanently altered in almost every aspect of daily life. SCI is a bodily (biological) damage that is closely linked to several social and psychological repercussions. Research indicated a widespread prejudice toward those with impairments. These may lead to institutional or professional stigma, as well as stigma against oneself or in public. Following a stroke, people who experience high levels of self-stigma are very aware of how they come across to others and interact with them, which can lead to a feeling of social disengagement (Budd, Gater and Channell 2022, pp. 1-3).

The management of people with SCI is therefore complex, involving many healthcare professionals, organizations, and government services. The immediate goal in the acute phase of SCI is to minimize further damage to the spinal cord. This often involves immobilization of the spine and prompt medical intervention to stabilize the patient's condition. The medical team works to optimize the patient's chances of recovery, which may include surgical procedures, medications, and other interventions. In the acute stage, physiotherapy plays a crucial role in managing respiratory complications. This includes techniques to prevent pneumonia and maintain lung function, as individuals with SCI may experience respiratory muscle weakness. Rehabilitation following SCI commences as soon as the patient is medically stable after injury. This can vary from a few days to many weeks (Harvey 2016, pp. 5-6).

Non-invasive interventions including various types of motor training, such as ladder walking, reaching, bicycling, swimming, and locomotor training on a treadmill decrease the inflammatory response, increase neurotrophins levels, and may strengthen spared functions and guide spinal reorganization. Physical activity and motor training can help modulate the inflammatory response, potentially reducing secondary damage to the spinal cord. Motor training can stimulate the release of neurotrophic factors (neurotrophins) that support the survival and growth of nerve cells, promoting neural recovery. By targeting specific muscle groups and motor pathways, motor training can enhance spared functions, potentially leading to improved mobility and independence. Motor training may contribute to adaptive changes in the spinal cord's neural circuits, promoting functional recovery and reorganization (Côté et al. 2017, pp. 1844-1851).

Physiotherapy during the rehabilitation phase focuses on goals related to motor tasks such as walking, pushing a wheelchair, transferring, and using the upper limbs. Assessments of impairments are of limited interest to a physiotherapist without accompanying assessments of activity limitations to quantify a person's ability to move and complete purposeful motor tasks (Harvey, 2016, p. 6).

A randomized controlled study was done to evaluate the effectiveness of step training with body weight support on treadmill. The control group received ground mobility therapy. The study included participants with incomplete SCI rated as B, C, D AIS. Both groups received 12 weeks of treatment and their walking speed was evaluated. No significant difference was found as step training and ground mobility therapy were equally effective in terms of improving walking speed. In intergroup analysis it was revealed that incomplete C and D patients had the greatest outcomes (Dobkin et al. 2006, pp. 484-488).

Different robotic interventions are nowadays gaining the interest of many researchers. A clinical trial was conducted to evaluate the effectiveness of Exoskeleton-assisted walking in terms of mobility and pulmonary function. The pulmonary function was examined in terms of pulmonary function test and the walking ability was measured using 6-minute walk test. It was a single-center study among 18 patients. The Exoskeleton group had a greater significance compared with the conventional therapy group in both pulmonary function and walking ability. Most of the patients had thoracic spine involvement that contributed to impaired pulmonary functioning. The author has suggested to perform more robotic training interventions among larger samples (Xiang et al. 2021, pp. 4-8).

In recent years, epidural electrical stimulation in SCI has piqued the interest of researchers. However, because this treatment is rather expensive, subcutaneous stimulation can also have a positive effect on patients' functionality. To determine the extent of effect of self-assisted training by non-invasive spinal stimulation a study was conducted in USA, including patients with A-C AIS category. The trial enrolled 15 participants according to the inclusion criteria and received Transcutaneous electrical spinal cord stimulation (tSCS)

which was set to monophasic 1ms pulses, at a frequency ranging within 0.2 to 30 HZ and stimulation intensity up to 150 mA. The control group received ineffective stimulation. The biofeedback was recorded using surface electromyogram (EMG) by bilateral polar surfacing over lower limb muscles. After receiving 3 weeks of treatment the experimental group was evaluated with a higher increase in EMG activity than control group (Sayenko et al. 2019, pp. 5-13).

Pain is indeed a frequent complaint among individuals with SCI. It can manifest in various forms, including neuropathic pain, musculoskeletal pain, and visceral pain. The prevalence of pain after SCI can vary depending on the level and severity of the injury. Neuropathic pain is more common in individuals with higher-level injuries, such as cervical or thoracic injuries. It often hampers the expected outcome and is an obstacle to continuing rehabilitation programs. This type of pain can manifest as burning, shooting, stabbing, or electrical sensations and is often resistant to traditional pain management approaches. With the aim to enable the patients to cope up with chronic neuropathic pain a multicenter study was done in 4 Dutch rehabilitation centers. The primary outcome was measured by using a pain-related disability questionnaire. Patients were evaluated in three phases, firstly at the beginning of the trial, after 3 months and after 6 months after discharge. The experimental group was enrolled in a cognitive behavioral program. The pain reduction was observed significant over time and patient reported of decreased anxiety and showed more eagerness in receiving rehabilitation interventions (Heutink et al. 2012, pp. 122-126).

Rehabilitative exercises are known to improve the neural activity in a SCI patient. So, any intervention that could enhance the effects of conventional therapy can be adopted in order to improve the expected outcomes. A theory named corticospinal-motor neuronal plasticity was hypothesized to understand if it is useful in enhancing exercising effects. To develop corticospinal-motor neuronal plasticity among SCI patients, paired corticospinal-motor neuronal stimulation was experimented and the control group received non-effective stimulation. The study was performed among 13 individuals with SCI who met the inclusion criteria. Participants exercised for 45 minutes after stimulation. Redefined Assessment of Strength, 10-meter walk test was used to evaluate the outcomes. The

outcomes were significant and are suggested as an effective strategy to improve exercise outcomes (Jo and Perez 2020, pp. 1-3).

Injuries to the upper cervical area can affect the function of the diaphragm and other respiratory muscles. The diaphragm, controlled by the phrenic nerves originating from the cervical spinal cord, plays a critical role in breathing. Damage to these nerves can lead to paralysis of the diaphragm and impaired breathing. Individuals with upper cervical SCI may experience decreased chest wall function due to weakened intercostal muscles, which are responsible for expanding and contracting the ribcage during breathing. This reduced chest wall movement can further compromise respiratory function. In addition, impaired breathing function reduces the capability of using wheelchair and increases fatigue. With the aim of improving breathing function a clinical trial was performed for testing inspiratory muscle training program. The tested outcomes were aerobic capacity, respiratory muscle strength and the level of fatigue. The trial group receives 15 minutes of training for 5 days a week. The total duration of this study was 4 weeks. The control group received conventional breathing exercises. After taking the results, it was found that both groups were effective in improving breathing capacity (Soumyashree and Kaur 2020, pp. 1-5).

Improving the mobility of an individual is one of the most crucial factors in enabling a person's functional independence. The most common hinderance to a SCI patient functioning is loss of mobility. Different concepts were tested to evaluate their effect on improving mobility. Locomotor training is one of the most widely used techniques that are prescribed by a physiotherapist. To understand deeply the effect of locomotor training, a study was performed to specifically understand the kinematic and neuromuscular adaptation after receiving locomotor training. The patients were enrolled in terms of having either AIS C or D and other criteria. The primary outcome goals included- maximum number of steps in a specific direction, increasing difficulty in walking tests as tolerated by the participant. 12 patients among 17 participants completed the study and their outcomes were recorded by using various EMG recordings. The results revealed a significant improvement in kinematics, especially in hip movements. By recording the

EMG, it was also revealed that locomotor training improves neuromuscular coordination (Ardestani et al. 2019, pp. 3-8).

Some common gym equipment can also be used to facilitate the motor function as well as walking ability of a spinal cord injured patient. Treadmill training is a widely used method for improving gait function and overall spinal stability in individuals with SCI. It involves repetitive stepping on a treadmill with or without body weight support. The goal is to promote walking-like movements and improve neuromuscular coordination. Treadmill training can be adapted to the individual's level of injury and functional abilities, making it suitable for a wide range of SCI patients 16 participants were randomized in a study to compare the effectiveness of robot training with weight-shifting treadmill training. Patients were evaluated using a 6-minute walk test after 8 weeks of intervention. A greater level of significance was showed by robotic training rather than weight-shifting treadmill training (Wu et al. 2018, pp. 4-18).

As SCI patients are often engaged in a prolonged posture for most of the day, they sometimes present with pulmonary dysfunctions. Pulmonary dysfunctions include difficulty in breathing, sputum production, reduced chest wall expansion and others. As we all know the diaphragm is the major muscle of respiration, it is crucial to strengthen and stabilize it to allow an individual to preserve normal breathing function. Abdominal drawing-in maneuver is a sophisticated exercise that mainly targets the voluntary control of the diaphragm. A clinical trial was conducted to evaluate the effectiveness of respiratory muscle training while combining it with abdominal drawing-in maneuver. 37 participants were enrolled for this study who had a level of C4-T6 spinal cord lesion. The outcome was measured using a spirometer reading and a stabilizer. The experiment was performed for 8 weeks, and post test results were taken. The control group received inly conventional breathing exercises. The outcomes were suggestive of a significant increase in functioning if the breathing when compared with control group (Kim et al. 2017, pp. 2-7).

It is already known that chronic SCI patients are exposes to pulmonary difficulties. And it is often considered as a common cause of death among SCI patients. A randomized controlled trial evaluated one of the respiratory complications known as normocapnic

hyperpnea response to respiratory muscle endurance program. This single centered study was performed among 18 participants with chronic SCI. The trial took place for 4 weeks and the results were taken. Results reveal that respiratory endurance program was not effective for improving the following condition. The author argues that it was too late to start an endurance program. But the effectiveness of respiratory endurance program was already proven among acute SCI patients. The author also commented that early respiratory endurance training could prevent the occurrence of respiratory complications (Xi et al. 2019, pp. 1-3).

Shoulder pain is a prevalent and well-documented problem in SCI patients who use wheelchairs. The repetitive stress placed on the shoulders during wheelchair propulsion can lead to various shoulder issues. Pushing a wheelchair requires repetitive use of the shoulder and upper limb muscles. Over time, this can lead to wear and tear, resulting in pain. Shoulder pain can limit an individual's ability to perform daily activities, including transfers, self-care, and reaching tasks. It can also hinder participation in social and recreational activities, leading to a decreased quality of life. With the intent to effectively manage shoulder pain a study was launched involving the patients in a series of home-based exercise programs. The exercise program included warm-up, stretching, and strengthening of major muscles of the shoulder. Strengthening was done by using either dumbbell or resisted bands. Patients were instructed to do 3 sets of 15 repetitions for strengthening exercises and 1 to 2 minutes interval between exercises. The results are suggestive of improving shoulder pain and prevention of recurrence was found on follow up (Mulroy et al. 2011, pp. 307-313).

CHAPTER III METHODOLOGY

3.1 Study Design

Quasi experimental design differs from a true experimental design in that, although it contains an independent variable that is manipulated to look for an effect on a dependent variable, either control group or randomization is lacking. These designs are useful to researchers looking for validation of treatment method and techniques, (Bailey, 1997). In experimental design, all three of the components- manipulation, control and randomization-are required. (Bailey, 1997). In this study control group was absent the outcomes were measured by comparing pre-test and post-test results. So, this is called the one-group pretest-posttest design.

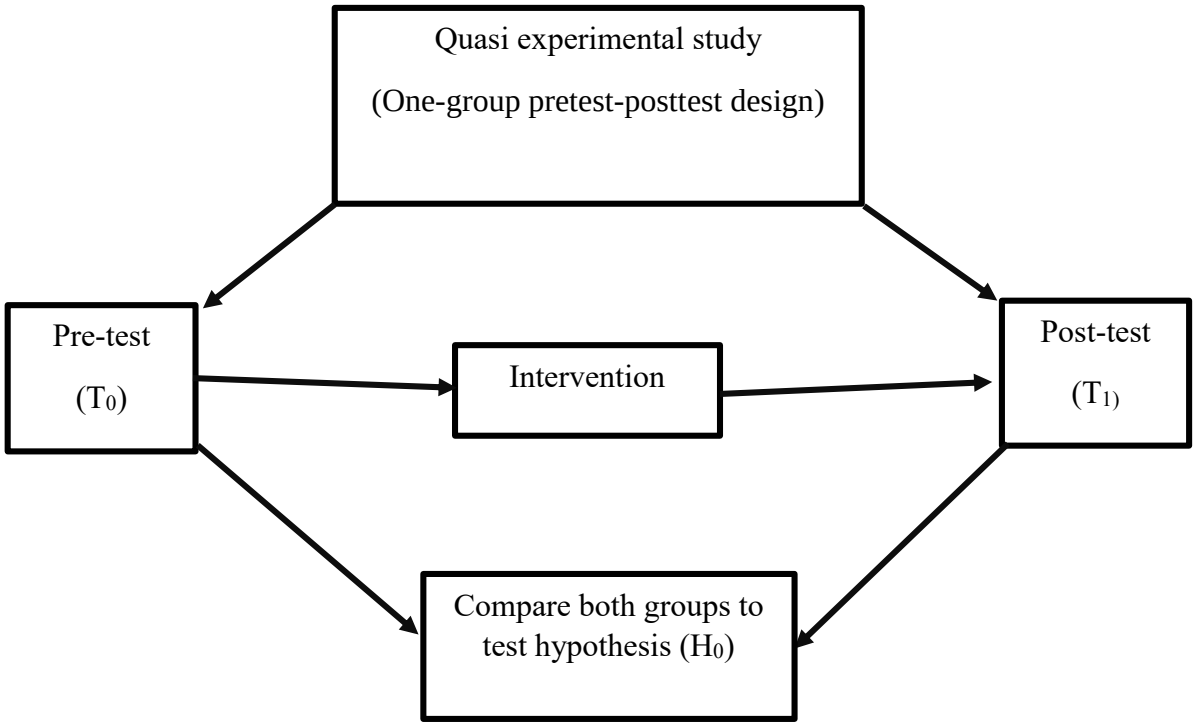
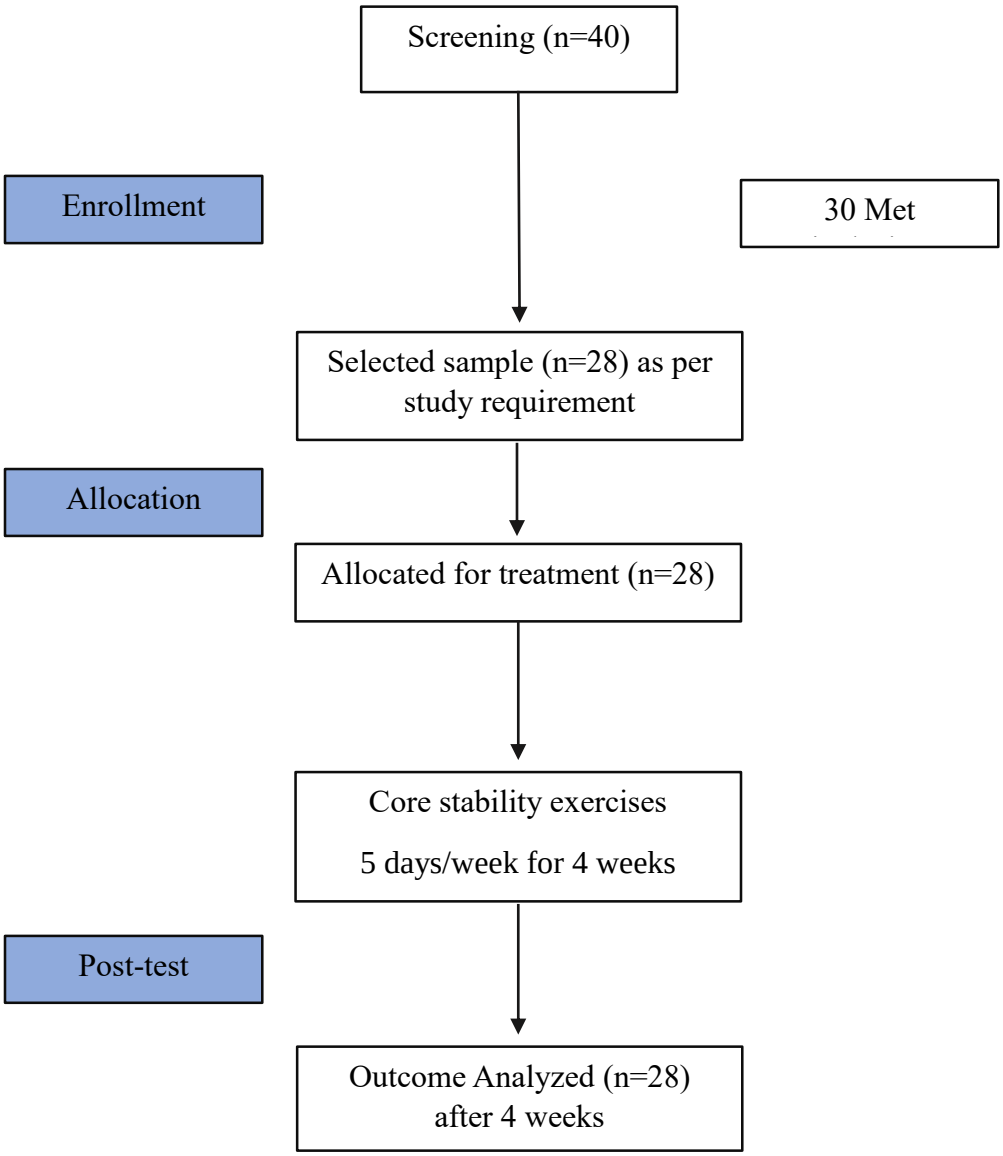


Figure 1: Study design

3.1.1 CONSORT Flowchart



3.2 Study Site

Physiotherapy department of Spinal Cord Injury Unit, CRP, Savar, Dhaka- 1343.

3.3 Study Population

The study population was the patients diagnosed with spinal cord injury attended in the SCI unit of physiotherapy department at CRP, Savar, Dhaka.

3.4 Study Duration

This study will take about 5 months.

3.5 Data collection duration

Data will be collected from April 2023 to June 2023

3.6 Method of sample selection

- **Inclusion criteria**
    1. Patients with history of ASIA Impairment Scale (AIS) grade C and D SCI (Kakade and Kanase 2020, p. 986).
    2. Both male and female participants (Soumyashree and Kaur 2020, pp. 3).
    3. Patients who will give consent to participate in the study.
    4. People of 18 years or above (Wilroy et al. 2021, p. 58).
- **Exclusion criteria**
    1. Neurological illness other than SCI.
    2. Patients who have withdrawn from rehabilitation program of CRP.
    3. Outdoor service receiving patients.

3.7 Sample Size

According to the inclusion and exclusion criteria 28 patients were selected for this study.

3.8 Sampling Technique

The sampling procedure was hospital based on a simple random sampling technique**.** In this sampling procedure, the sample depends entirely on chance and is known as the method of chance selection. In this sampling technique, every item of the population is given an equal chance of getting selected as a sample.

3.9 Method of Data collection

- **Data Collection Tools:** Data collection tools were informed consent form, semi-structured questionnaire, papers, pen, and pencil.
- **Measurement Tools**
    - A socio-demographic questionnaire was used to know the socio-economic status of the patient that was related to SCI.
    - American Spinal Injury Association (ASIA) Impairment Scale was used to measure the SCI level. The probable incomplete C, D.
    - Spinal Cord Independence Measure version 3 (SCIM-3) was used to measure the functional independence of SCI patients. It is a 100-point scale consisting of 3 parts: self-care, respiratory and sphincter management, and mobility.
        - The self-care subscale is of 20 score and has 4 questions. The four questions include feeding, bathing (upper and lower body), dressing (upper and lower body) and grooming.
        - Respiratory and sphincter management subscale is of 40 score and has 4 questions. The questions are about respiration, sphincter management- bladder, sphincter management- bowel, use of toilet.

- Mobility (room and toilet) subscale is of 40 score and has 9 questions. The questions are about mobility in bed and action to prevent pressure sores, transfers: wheelchair-toilet-tub, mobility indoors, mobility for moderate distances, mobility outdoors, stair management, transfers: wheelchair-car, transfers: ground-wheelchair.

3.10 Data collection procedure

The data collector fixed a date and time with the participant to his available time. First the data collector informed the participant about the contents of the consent form. All participant names coded to maintain confidentiality, diagnosed, and referred by qualified physiotherapist and doctor. Each participant received core stability exercises for their functional impairments. Participant evaluated by SCIM-III scale for their functionality and ASIA for measurement of their level of spinal cord injury. The participants of the research were chosen purposively for the experiment. Then the data collector measured the level of spinal cord injury and initial functionality. The participants received treatment as regular patients in the SCI department of CRP; they continue their treatment as per their schedule. Each participant received 5 days per week. The treatment program arranges for 6 weeks by the researcher with permission from the spinal cord injury unit. Before the researcher started the treatment, he took a pre-test data including the patient's spinal cord injury level and initial functionality.

After taking the pretest data, the patients received core stability exercises according to the treatment schedule. After 6 weeks of intervention a post test data was taken for the final assessment of functionality and level of spinal cord injury. The SPSS version 20.0 software was used in performance of statistical analyses for the mean and standard deviation.

3.11 Intervention

Table 1: Treatment protocol

Intervention	Intensity
Crunch (Sung, Yoon and Park 2015, p. 951)	10 reps X 4 set
Abdominal drawing-in maneuver while sitting (Saiklang, Puntumetakul and Chatprem 2022, p. 6)	10 rep X 10s hold X 3set
Anterior-posterior tilt of pelvis (Haruyama et al. 2016, p. 242)	10 rep X 10s hold X 3set
Clampshell exercise (Jeong et al. 2019, pp. 13)	10 rep X 5s hold X 3set

All interventions should be carried out 5 days/week for 4 weeks.

3.12 Data analysis

Statistical analysis will be performed using the statistical package for social science (SPSS) version 20. The researcher will use the pie chart, bar chart, linear line diagram, and inferential statistical test.

3.12.1 Statistical test

Statistical analysis refers to the well-defined organization and interpretations of the data by systemic and mathematical procedure and rules.

Hypothesis Test

Wilcoxon Test

This test, also known as Wilcoxon matched pair, signed ranked test, is an alternative to the paired t test, when the assumption of normality or equality of variances is not meet. When there are just measures to be compared from the same case, and data are normally distributed or the sample size is large, we apply a paired t test. In this situation if the data is not normally distributed then use Wilcoxon test. Since my study sample was 28 and it was not normally distributed, I will use Wilcoxon signed rank test. Calculated z value is

compared with table z value to find p value. If p< .05, we reject the null hypothesis. If otherwise, we cannot reject the null hypothesis and accept it.

Equation/Formula:

$$z = \frac{T - \frac{N(N+1)}{4}}{\sqrt{\frac{N(N+1)(2N+1)}{24}}}$$

Here,

T=Lowest value among positive and negative rank

N=Total number of the participants

Z=Value of the Wilcoxon matched pair signed rank test

Interpretation:

Calculated z value is compared with table z value to find p value. If p< .05, we reject null hypothesis. If otherwise, we cannot reject the null hypothesis and accept it.

3.13 Ethical Consideration

The researcher maintained some ethical considerations: A Research proposal was submitted to the physiotherapy department of BHPI for approval and the proposal was approved by the faculty members and gave permission initially from the supervisor of the research project and from the course coordinator before conducting the study. The proposal of the dissertation including methodology was presented to the Institutional Review Board (IRB) of Bangladesh Health Professions Institute (BHPI) for oral presentation defense was done in front of the IRB. Then the necessary information was approved by the Institutional Review Board and was permitted to do this research. After getting permission to do this study from the academic institute the researcher started to do it. The researcher had been given permission for data collection from the Musculoskeletal unit of Savar, CRP. Researcher followed the Bangladesh Medical Research Council (BMRC) guideline & WHO research guideline. The researcher was eligible to do the study after knowing the academic and clinical rules of doing the study about what should be done and what should

not. All rights of the participants were reserved, and the researcher was accountable to the participant to answer any type of study related question.

CHAPTER IV RESULTS

4.1 Age of participants

The following sociodemographic data describes the percentage of age among 28 participants who were diagnosed with incomplete C and D SCI. The mean age of the participants is 37 and standard deviation is 14.271. The pie chart shows that participants within 18-28 years of age are the majority among analyzed age intervals.

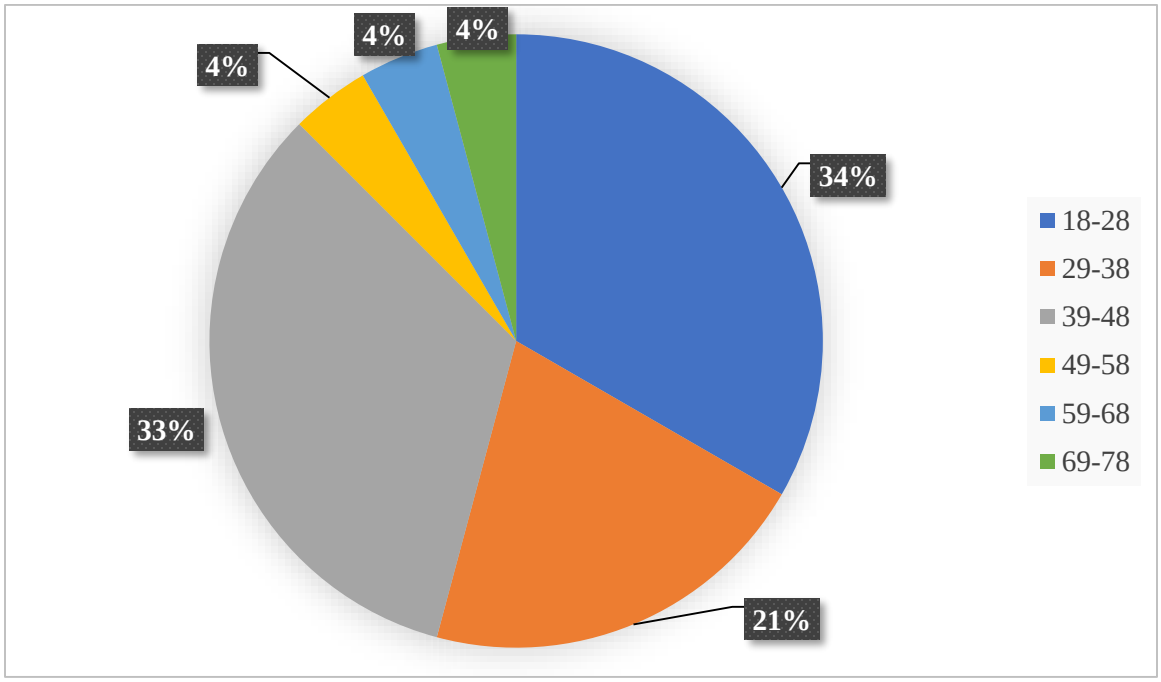


Figure 2: Age of participants

4.1.1 Age variables

Table 2: Age of the participants

Participant no.	Age	Participant no.	Age
1	40	15	45
2	65	16	71
3	22	17	37
4	45	18	35
5	35	19	23
6	39	20	48
7	42	21	35
8	20	22	20
9	35	23	23
10	18	24	45
11	20	25	65
12	45	26	45
13	25	27	42
14	55	28	26

In this study the age variables of 28 participants were measured. The mean age of participants was 38.07 ± 14.460.

4.2 Gender Ratio

Among 28 patients with incomplete C and D SCI who participated in this study, 75% (n= 21) were male and 25% (n=7) were female.

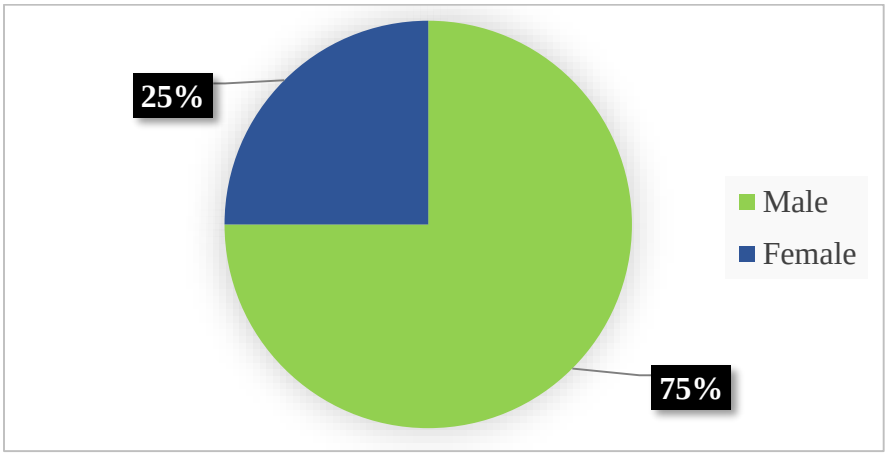


Figure 3: Gender ratio

4.3 Cause of injury

The common causes of injury which are responsible for SCI were analyzed. 42.9% (n=12) patients among 28 participants did fall from height and were diagnosed with SCI. The second most common cause was road traffic accidents (RTA) which was responsible for 21.4% (n=6) patients. The other causes were shallow water diving (17.9%, n=5), scarf injury (7.1%, n=2), physical assault (3.6%, n=1), and other traumatic causes (7.1%, n=2).

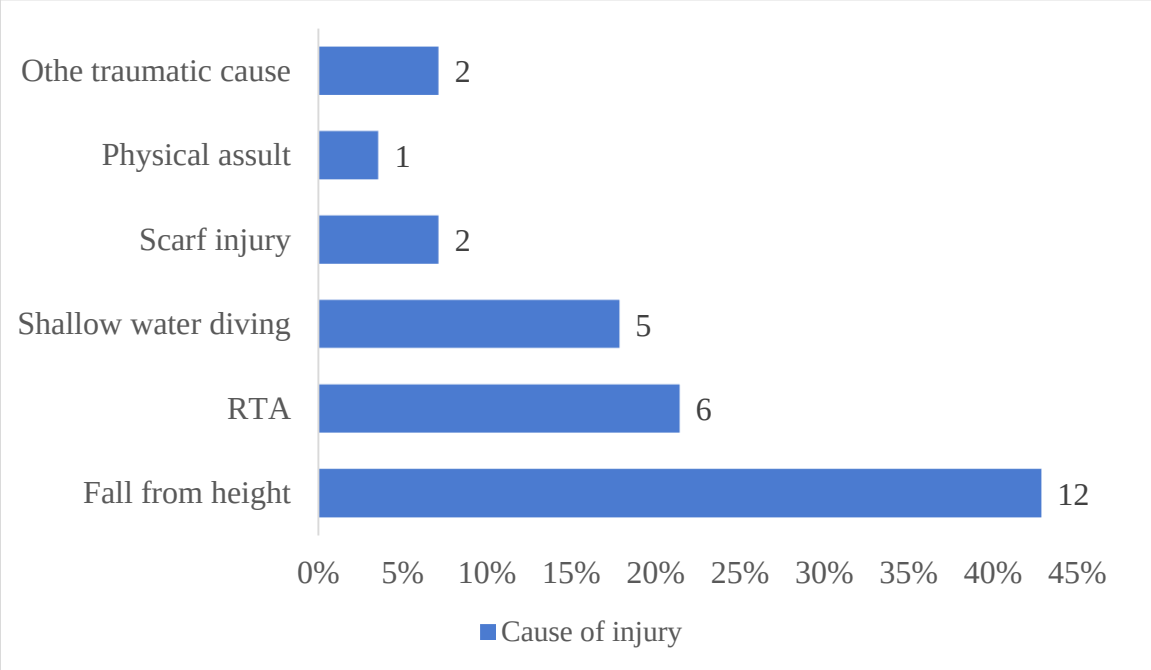


Figure 4: Cause of injury

4.4 Educational level

The educational level extends from no formal education up to post graduation. 28 participants' educational level was measured, and we found that the most common educational level among the participants was higher secondary (28.6%, n=8). The other participants were 10.7% (n=3) primary, 28.6% (n=5) secondary and 21.4% (n=6) graduate level educated. Only 1 (3.6%) participant completed post-graduation.

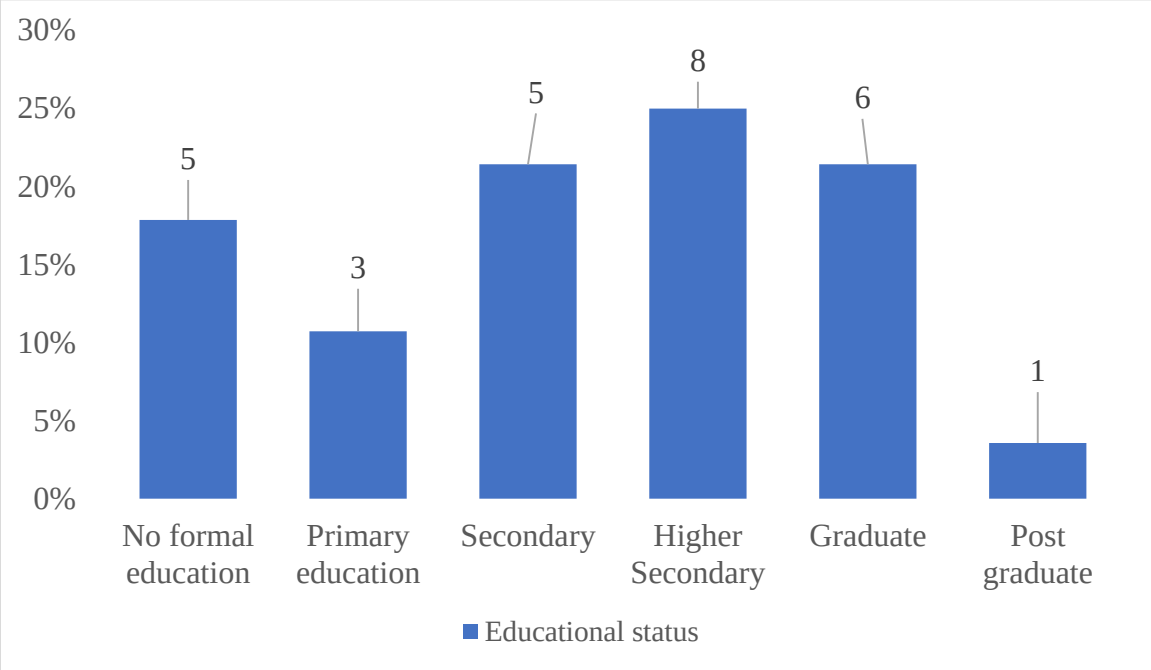


Figure 5: Educational level

4.5 Occupational status before SCI

The occupational status was measured by analyzing data found from 28 participants. The occupations were housewife (n=1), shopkeeper (n=7), farmer (n=5), service holder (n=3), businessman (n=4), day labor (n=2), student (n=3), unemployed (n=1) and others (n=2).

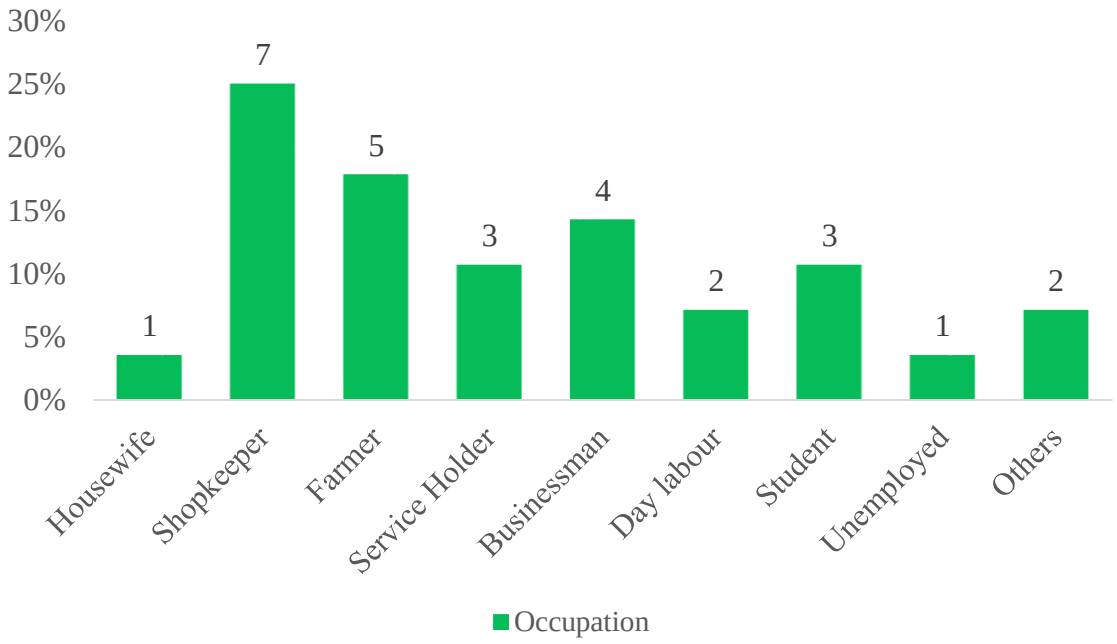


Figure 6: Occupational status before SCI

4.5 Type of paralysis

After evaluating the previous medical history, we evaluated the type of paralysis among the participants. Among 28 participants, 57.1% (n=16) participants were diagnosed with traumatic paraplegia. The remaining 42.9% (n=12) participants were traumatic tetraplegic.

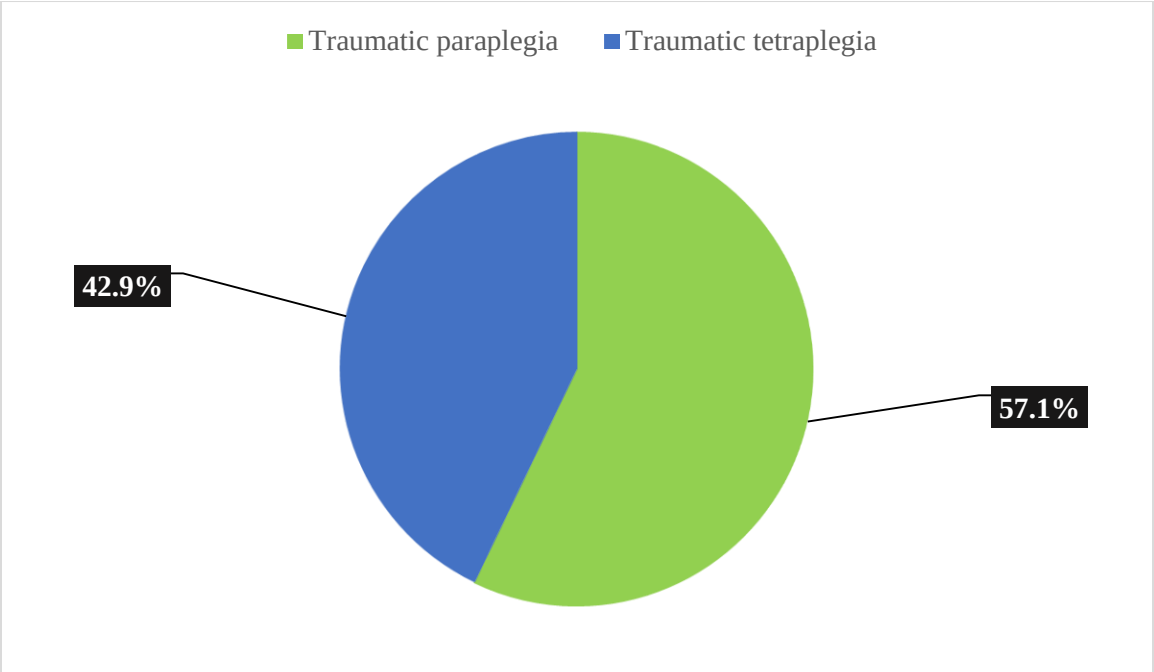


Figure 7: Type of paralysis

4.6 AIS Category

After analyzing the data collected from 28 participants, we found that 71.4% (n=20) participants were incomplete D and the remaining 28.6% (n=8) participants were incomplete C.

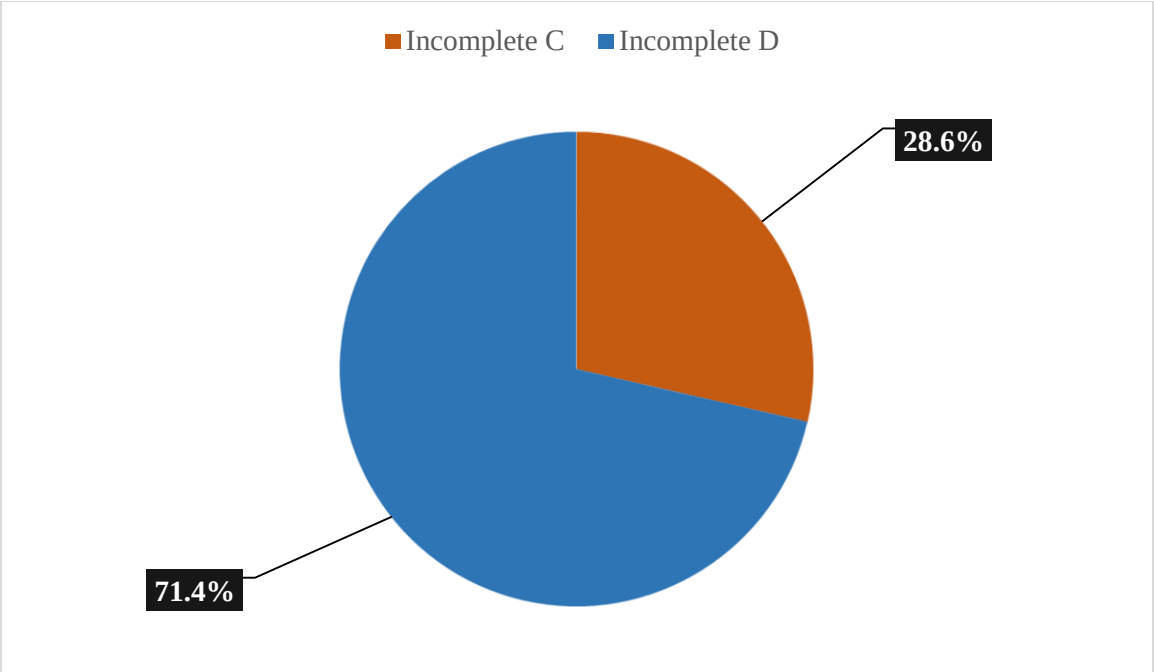


Figure 8: AIS category

4.7 Co-morbidities after SCI

Co-morbidities that arrive after SCI were evaluated among patients. The questionnaire included co-morbidities such as pressure sore, depression, bowel bladder dysfunction, respiratory complications, postural hypotension, urinary incontinence, circulatory problem, spasticity or the presence of more than one complication. It was found that 71.4% (n=20) participants suffered from multiple co-morbidities and 28.6% (n=8) participants only had spasticity in their distal limbs.

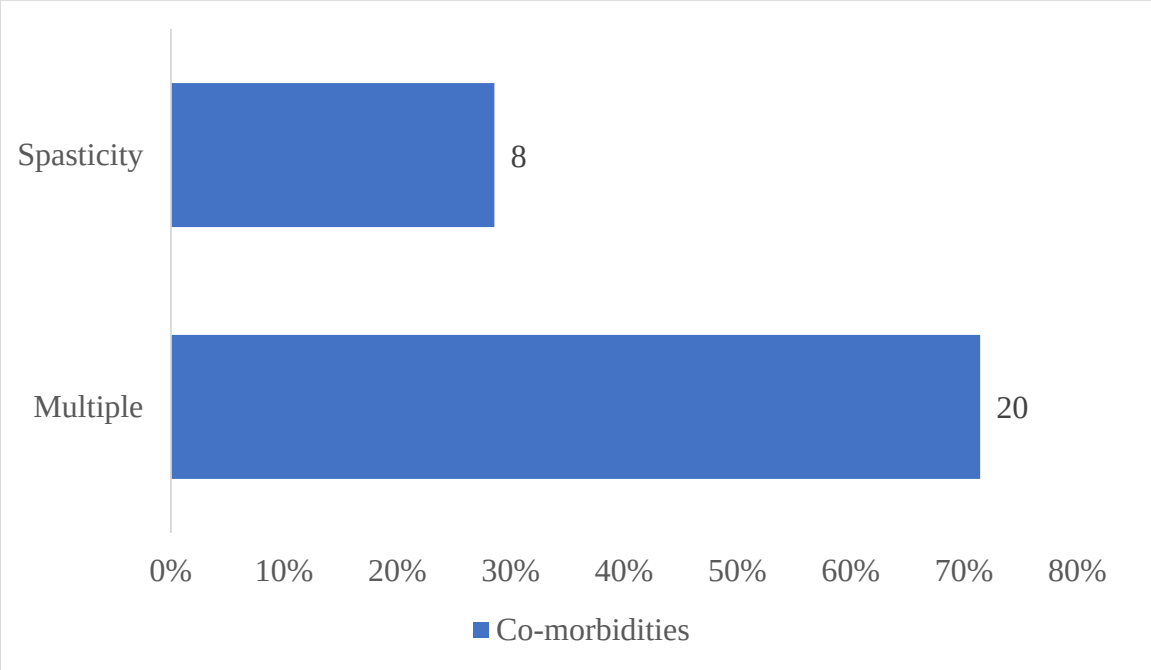


Figure 9: Co-morbidities after SCI

4.8 Duration of injury

Duration of injury was measured by considering the date of accident and the date of data collection for pre-test. The most common duration of injury is 2 months (50%, n=14). The remaining 46.4% (n=13) participants had SCI before 3 months and 3.6% (n=1) participants had SCI before 1 month.

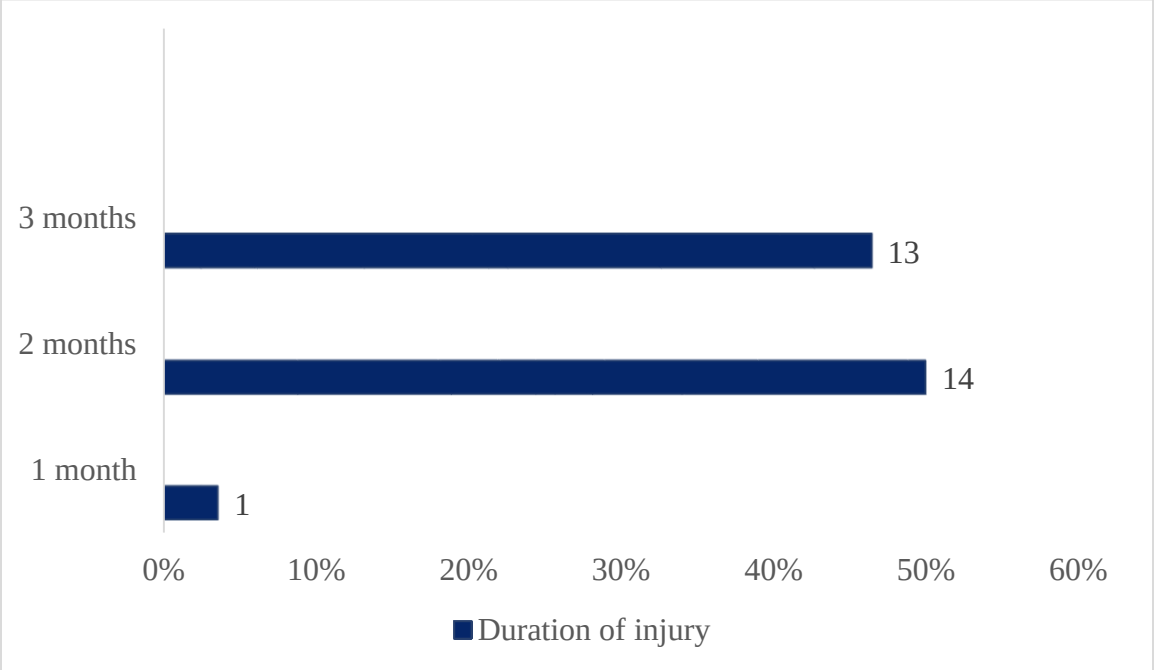


Figure 10: Duration of injury

4.9 Functional independence status

Table 3: Mean and standard deviation (SD) of total independence status of the participants

N=28	SCIM total pretest	SCIM total posttest	Mean difference
Mean	50.71	63	9.29
SD	6.599	11.225	

The table presents the mean total SCIM score of pre-test and post-test group as well as their mean difference. The total number of participants was 28. The mean for the pre-test group was 50.71, SD= 6.599 and post-test group was 63, SD= 11.225. The mean difference between pre and post-test of the participants has been found to be 9.29. As mean represents all the components of the samples, initially we can say that the total score has increased in participants after 4 weeks of intervention.

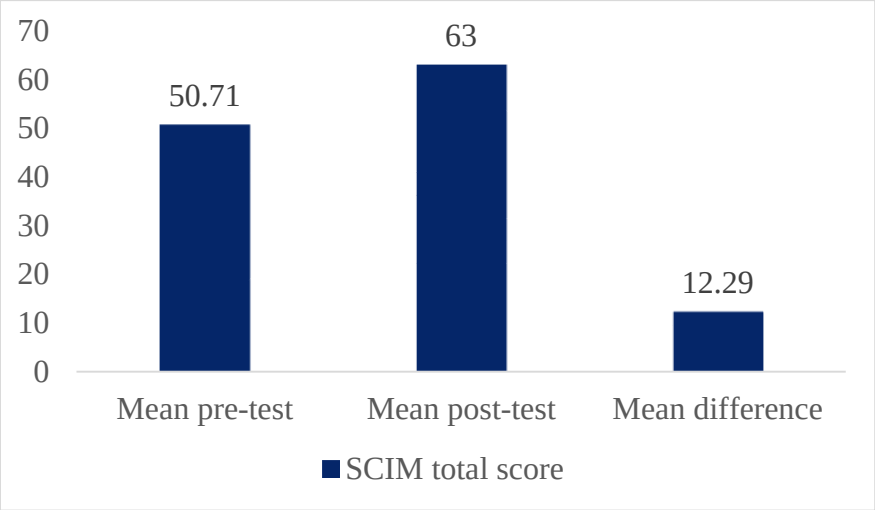


Figure 11: Comparison between mean of pre-test and post-test total scores

4.9.1 Analysis of Functional independence

Wilcoxon Signed Rank test by comparing between Pre-test and Post-test total score.

Table 4: Calculation of Z value for Pre-test and Post-test functional independence

Pre-test and Post-test functional independence			
Spinal Cord Independence Measure, version III (SCIM-III)	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	28	- 4.627	0.001*
Negative ranks	0		
Ties	0		
Total	28		

The table displays the comparison of the participants before (pre-test) and after (post-test) SCIM total score. According to the table's legend, none of the participant's total independence score decreased. The total functional independence score of 28 participants was 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 the alternative hypothesis is accepted, and the null hypothesis is rejected.

4.10 Analysis of Self care

Table 5: Mean and standard deviation (SD) of Self-care status of the participants

N=28	Self-care pretest	Self-care posttest	Mean difference
Mean	11.39	17.11	5.72
SD	2.283	2.572	

The table presents the mean Self-care score of pre-test and post-test group as well as their mean difference. The total number of participants was 28. The mean for the pre-test group was 11.39, SD= 2.283 and post-test group was 17.11, SD= 2.572. The mean difference between pre and post-test of the participants has been found to be 5.72. As mean represents all the components of the samples, initially we can say that the ability to do self-care functions has increased in participants after 4 weeks of intervention.

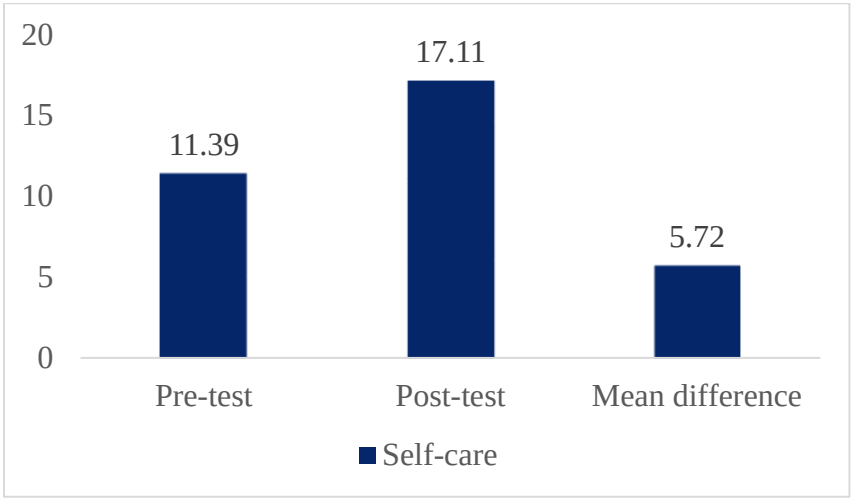


Figure 12: Comparison between mean of pre-test and post-test of self-care scores.

4.10.1 Analysis of Self-care

Wilcoxon Signed Rank test by comparing between Pre-test and Post-test Self-care score.

Table 6: Calculation of Z value for Pre-test and Post-test of Self-care

Pre-test and Post-test Self-care			
Self-care subscale of SCIM-III	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	28	- 4.635	0.001*
Negative ranks	0		
Ties	0		
Total	28		

The table displays the comparison of the participants before (pre-test) and after (post-test) Self-care scores. According to the table's legend, none of the participant's total self-care score decreased. The total self-care independence score of 28 participants was higher after the intervention. The point 'ties' indicate that no patient's total self-care 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 has been found a significant improvement in self-care function through interventions.

4.11 Analysis of Respiration and Sphincter Management

Table 7: Mean and standard deviation (SD) of Respiration and Sphincter Management of the participants

N=28	Respiration and Sphincter Management Pre-test	Respiration and Sphincter Management Posttest	Mean difference
Mean	28.89	29.36	0.47
SD	3.871	4.708	

The table presents the mean Respiration and Sphincter Management score of pre-test and post-test group as well as their mean difference. The total number of participants was 28. The mean for the pre-test group was 28.89, SD= 3.871 and post-test group was 29.36, SD= 4.708. The mean difference between pre and post-test of the participants is 0.47. As mean represents all the components of the samples, initially we can say that the ability to manage respiration and sphincter has increased slightly participants after 4 weeks of intervention.

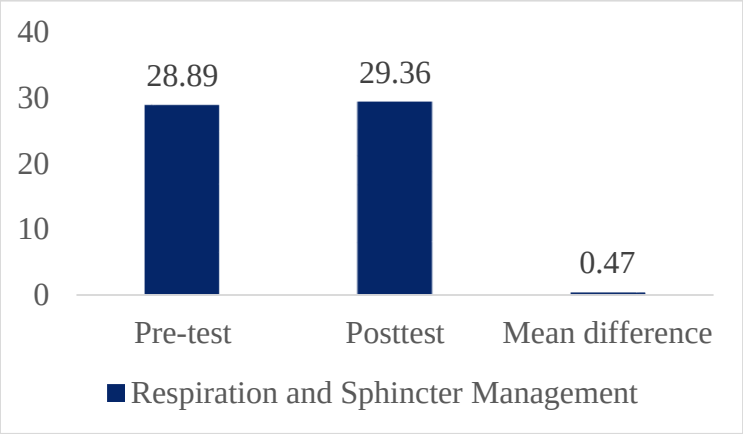


Figure 13: Comparison between mean of pre-test and post-test of Respiration and Sphincter Management mean

4.11.1 Analysis of Respiration and Sphincter Management

Wilcoxon Signed Rank test by comparing between Pre-test and Post-test Respiration and Sphincter Management.

Table 8: Calculation of Z value for Pre-test and Post-test of Respiration and Sphincter Management

Pre-test and Post-test Respiration and Sphincter Management			
Respiration and Sphincter Management subscale of SCIM-III	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	6	- 1.266	0.205
Negative ranks	3		
Ties	19		
Total	28		

The table displays the comparison of the participants before (pre-test) and after (post-test) of Respiration and Sphincter scores. Respiration and Sphincter Management subscale is a scale of 40 score. According to the table, there has been found 6 positive and 3 negative ranks. The remaining ranks are ties that means the same score of pre-test and post-test. The significant p-value is 0.205 in which there is less than a 5% chance that the results are due to random error, and it is not significant. Therefore, it can be said that no significant improvement has been found in Respiration and Sphincter Management function through interventions.

4.12 Analysis of Mobility (room and toilet)

Table 9: Mean and standard deviation (SD) of Mobility (room and toilet) of the participants

N=28	Mobility (room and toilet) Pre-test	Mobility (room and toilet) Posttest	Mean difference
Mean	8.93	16.36	7.43
SD	1.942	4.048	

The table presents the mean Mobility (room and toilet) score of pre-test and post-test group as well as their mean difference. The total number of participants was 28. The mean for the pre-test group was 8.93, SD= 1.942 and post-test group was 16.36, SD= 4.048. The mean difference between pre and post-test of the participants has been found to be 7.43. As mean represents all the components of the samples, initially we can say that the ability to do self-care functions has increased in participants after 4 weeks of intervention.

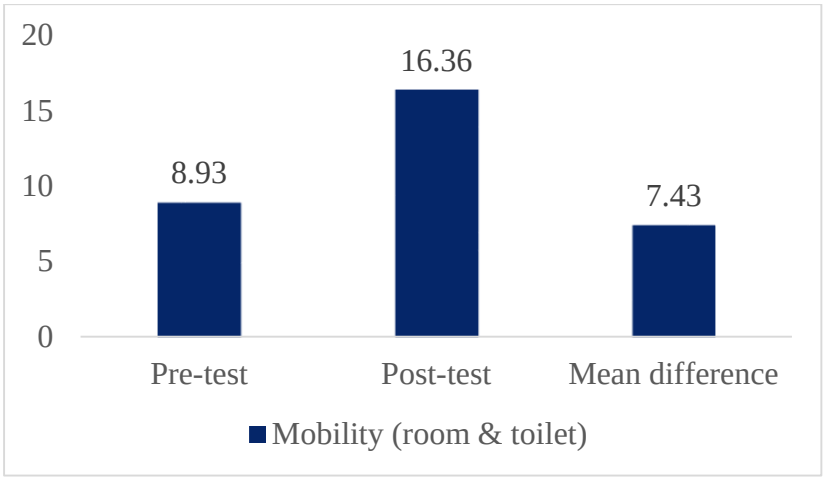


Figure 14: Comparison between mean of pre-test and post-test of Mobility (room and toilet)

4.11.1 Analysis of Mobility (room and toilet)

Wilcoxon Signed Rank test by comparing between Pre-test and Post-test Mobility (room and toilet) score.

Table 10: Calculation of Z value for Pre-test and Post-test of Mobility (room and toilet)

Pre-test and Post-test of Mobility (room and toilet)			
Mobility (room and toilet) subscale of SCIM-III	**N**	**Test Statistics (Wilcoxon Signed Rank Test)**	
		Z value	**p-value**
Positive ranks	26	- 4.470	0.001*
Negative ranks	0		
Ties	2		
Total	28		

The table displays the comparison of the participants before (pre-test) and after (post-test) Mobility (room and toilet) scores. According to the table's legend, none of the participant's total Mobility (room and toilet) score did not decrease. The point 'ties' indicate that 2 patient's total Mobility (room and toilet) 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 has been a significant improvement in Mobility (room and toilet) function through interventions.

CHAPTER V DISCUSSION

The purpose of the following study is to evaluate the impact of Core Stabilization exercises on functional improvement in SCI patients with AIS categories incomplete C and D. Males makeup 75% of the sample, while females make up 25%. The age range chosen was 18 to 78. The most frequent cause of injury was falling from a height, and the severity of the injuries was higher among the patients. Among 28 participants, 57.1% of patients had traumatic paraplegia and 42.9% had traumatic tetraplegia. Eight participants and twenty patients each received an AIS category incomplete D diagnosis. Most patients (71.4%) had numerous co-morbidities, while just a small percentage (28.5%) had solely spasticity.

A treatment protocol is maintained while receiving the exercises along with their daily treatment program. After 4 weeks of intervention, the functionality of the participants was measured by SCIM-3 scale that included questions on self-care, respiration and sphincter management and mobility in the room and in the toilet. The results show a significant ($p<0.05$) improvement in total functioning that was analyzed, considering the total score of the scale. Then the subscales were individually analyzed to find out the impact of exercise on these three subscales that included self-care, bowel-bladder management, and mobility functions.

In our study patients' ability to perform their self-care activity independently, has increased significantly ($p<0.05$). Loss of hand functions has always been a prime focus for a healthcare provider as the patient undergoes rehabilitation process. Different studies have been done to improve hand functions. A study was done on 15 patients to determine the effectiveness of robotic gloves with the aim to improve hand functions and self-care activities as they undergo home based rehabilitation. After 12 weeks of intervention, participants improved their hand functions, specifically pinching grip, and thumb functions (Osuagwu et al., 2020). But robotic hands are expensive and its wide usability irrespective of socio-economic status cannot be ensured. Active core stabilization exercises are attainable, and patients can keep performing them while receiving home-based

rehabilitation. However, not every Core Stabilization exercise is suitable for employment during acute stage. Robotic therapies may be more helpful in that regard.

Measurements of respiratory and sphincter functioning were also made for this study. However, some individuals did not experience any improvement, while others saw a decline in sphincter function. It was found not to be significant (p= 0.205) when the exercise effectiveness was measured for respiratory and sphincter management ability. All of the patients were either incomplete C or incomplete D, thus breathing wasn't that much involved. Although some patients' sphincter functions had improved, most of them did not exhibit an improvement in their bowel and bladder functions. A clinical trial was conducted to evaluate the effectiveness of respiratory muscle training while combining it with abdominal drawing-in maneuver concerning the immediate effect of the exercise. 37 participants were enrolled for this study who had a level of C4-T6 spinal cord lesion. The outcome was measured using a spirometer reading and a stabilizer. The experiment was performed for 8 weeks, and post test results were taken. The control group received inly conventional breathing exercises. The outcomes were suggestive of a significant increase in functioning if the breathing when compared with control group (Kim et al. 2017, pp. 2-7).

A clinical experiment for evaluating an inspiratory muscle training program was conducted with the goal of enhancing breathing function. Aerobic ability, respiratory muscle strength, and degree of tiredness were the tested results. The experiment evaluated participants' aerobic fitness levels to determine whether the training program had any positive effects on their overall cardiovascular endurance and oxygen utilization during physical activity. The strength of the respiratory muscles, particularly the inspiratory muscles responsible for inhalation, was assessed to gauge improvements resulting from the training program. Participants' self-reported levels of tiredness and fatigue were recorded to understand whether the training program had any influence on reducing the perception of tiredness during daily activities. In a 4-week clinical trial, the participants in the trial group underwent 15-minute training session five days a week, while the control group practiced standard breathing techniques. The goal of the trial was to assess changes in respiratory

capacity. Surprisingly, the results indicated that both groups were successful in increasing their respiratory capacity.

This outcome suggests that both the specialized training program and the standard breathing techniques had a positive impact on the participants' respiratory capacity. It underscores the importance of regular breathing exercises and indicates that even short, focused training sessions can lead to improvements in respiratory function. Such findings can be valuable for individuals looking to enhance their breathing and overall respiratory health (Soumyashree and Kaur 2020, pp. 1-5).

Lastly, mobility in room and toilet was another function that has been found significant ($p<0.05$). the participants had a significant improvement in limited to maximum distance mobility, pressure sore management and transfers. Participants experienced notable enhancements in their ability to move within both room and toilet environments. This suggests that the intervention or treatment being studied had a positive impact on their mobility. The study's results encompassed a range of mobility scenarios, from limited movement to maximum distance mobility. This indicates that the improvements were comprehensive and not limited to specific mobility conditions. There is a greater scope to enhance the Core Stabilization exercise program by combing it with higher level of exercises such as locomotor training. Locomotor training shares similar principles as the Core Stabilization exercises as it focuses on the patient’s active control over their core muscles. To understand deeply the effect of locomotor training, a study was performed to specifically understand the kinematic and neuromuscular adaptation after receiving locomotor training. The patients were enrolled in terms of having either AIS C or D and other criteria. It was found that locomotor training improves neuromuscular control over the core muscles thus improving overall mobility (Ardestani et al. 2019, pp. 3-8). The fusion of Core Stabilization exercises with locomotor training offers a well-rounded approach to core strength development. Locomotor movements, such as walking or stepping, demand substantial core muscle engagement for stability, balance, and coordinated movement. By including these dynamic activities, patients can build core strength more effectively than with static exercises alone. Robotic training is another way of intervention that has gained interest of many authors and have been proven to be more

effective than weight shifting techniques along with locomotor training(Wu et al., 2018). Non-invasive spinal stimulations are found effective in improving EMG activity of the muscles that has allowed the participants to enhance their mobility while undergoing conventional physiotherapy(Sayenko et al. 2019, pp. 5-13)

To determine the effectiveness of step training with body weight support on a treadmill, a randomized controlled trial was conducted. Therapy for ground mobility was provided to the control group. Participants with incomplete SCI graded as B, C, or D AIS were included in the study. Following a 12-week course of therapy, the walking speeds of both groups were measured. According to intergroup analysis, incomplete C and D patients had the best results (Dobkin et al. 2006, pp. 484-488)

Stabilization exercises are relatively new exercises that mainly focus on the overall rehabilitation of core muscles so that it can contribute to the neurodynamic of the spine. Many studies have been done that focus core muscle strength with the aim to improve proprioception and neural activity.

The study was done focusing solely on patients who had an incomplete injury. Participants had either half or more than half of the key muscle ability to work against gravity through the full range of motion. But acute SCI injury is paralyzing and not all the affected individuals can carry out the core stabilization exercises.

5.1 Limitations of the study

The amount of time to carry out the interventions was scanty. The study only focused the patients who had either incomplete C or D, so the results cannot be generalized for the population of SCI. Core Stabilization exercises require active control over the core muscles and if the patient is present with higher level of injury it may worsen their condition.

The fact that the study was conducted at a single center, CRP, may limit the generalizability of the findings to other healthcare facilities with different resources, patient populations, and practices. To understand the effectiveness of core stabilization exercises more comprehensively and to account for variations in patient demographics and resources, conducting multicenter studies involving different types of healthcare facilities is indeed would be valuable. Specifically, these exercises can be carried out in a cardio-respiratory specialized medical center to explore its effectiveness in respiratory functions.

It was a quasi-experimental design in which we determined the effectiveness of Core Stabilization in the presence of regular conventional therapy. Its effectiveness may be explored furthermore if the patients are randomized and controlled while isolating a group that will receive only Core Stabilization exercises.

CHAPTER VI CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In modern times among the most severe diseases in the world, spinal cord injury (SCI) is followed by a protracted and frequently ineffective healing process following trauma. The spinal cord is greatly harmed by spinal cord injury (SCI). The distal level of the injury causes an interruption in the spinal cord's ability to conduct its normal actions. Due to the limited capacity of the central nervous system to heal and the limited number of therapeutic alternatives available up to now, a spinal cord injury is a life-altering event that leaves most patients disabled or paralyzed throughout their lifetime.

The findings of this study suggest that Core Stabilization exercises have a positive impact on body functions. The study has focused specifically on three functions. Among them self-care and mobility functions have been found to be highly significant. Although the improvements were not significant when respiratory and sphincter functions were analyzed. A more effective treatment should be planned to improve respiratory functions and bowel and bladder management.

Early rehabilitation is crucial for a SCI patient so that he or she can return to their daily activity more quickly and allow them to reduce the chances to develop SCI related complications. So, to allow the patients to be able to perform Core Stabilization exercises in the initial period of their injury, functional stimulation modalities may boost the overall neural and muscular activity of core muscles.

Core Stabilization exercises are easy to perform, and the patient can carry out the exercises without the help of the therapist. Also, these exercises can be performed irrespective of the socio-economic status of the participant.

Core muscles are a box of power within the body. So, it requires no more saying of the importance of new exercises that focus core muscles.

6.2 Recommendation

This research is in the form of a quasi-experiment. When conducting significance tests, data from two distinct time periods are used, and quasi-experimental studies use data from the same group. There is no isolation inside the group, nor is there another kind of intervention. Exercises for core stability can be contrasted with other types of physical exercise, such as locomotor training, weight-supported exercises, or exercises that incorporate electrical stimulation. By separating a group and evaluating the results of an additional exercise or any combination of treatments, one may determine the benefits of core stability exercises alone. This scientific study had a brief duration. Since patients actively do these exercises, a longer duration of intervention may be necessary to determine the rate of adherence to core stability exercises.

Only patients with an incomplete C or D rating for paralysis are the subject of this study. Therefore, it is not possible to generalize the therapeutic procedure given to paraplegic individuals who have had SCI. When electrical stimulation is combined with core stability exercises, a variety of paralyzed individuals may benefit from this combination of treatments.

As previously noted, the subsequent trial did not demonstrate a statistically significant improvement in the respiratory and sphincter control of individuals with incomplete SCI. One of the most frequent issues following SCI is the development of respiratory difficulties and bowel bladder incontinence. To help SCI patients with their breathing and voiding mechanisms, more targeted activities have to be discovered and should be added with conventional rehabilitation program

Exercises for core stability are designed to increase a person's functioning. Therefore, the professionals in rehabilitation should allow the patients to perform everyday tasks on their own. Exercises for core stability combined with a traditional rehabilitation program will help patients achieve better neurodynamic integrity, which will boost their recovery.

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APPENDIX

অনুমতি পত্র

(অংশগ্রহণকারীকে পড়ার জন্য অনুরোধ করা হলো)

আসসালামু আলাইকুম,

আমি মাহদী উল বারী, ঢাকা বিশ্ববিদ্যালয় এর চিকিৎসা অনুষদের অন্তর্ভুক্ত বাংলাদেশ হেলথ প্রফেশন্স ইন্সটিটিউট এর বিএসসি ইন ফিজিওথেরাপি কোর্সের ২০১৭-২০১৮ শিক্ষাবর্ষের একজন শিক্ষার্থী। বিএসসি ইন ফিজিওথেরাপি ডিগ্রী অর্জনের জন্য আমাকে একটি থিসিস সম্পূর্ণ করতে হবে। আমার থিসিসটির শিরোনাম হল **"মেরুরজ্জুতে আঘাতপ্রাপ্ত রোগীদের দৈনন্দিন কার্যকলাপের মান উন্নয়নের জন্য কোর স্টেবিলাইজেশন ব্যায়ামের কার্যকারিতা"।** এই থিসিসটি অধ্যয়নের মূল লক্ষ্য হচ্ছে মেরুরজ্জুতে আঘাতপ্রাপ্ত রোগীদের দৈনন্দিন কার্যকলাপের মান উন্নয়নের জন্য কোর স্টেবিলাইজেশন ব্যায়ামের কার্যকারিতা নিরূপণ করা। এই থিসিস সম্পর্কিত আপনাকে কিছু প্রশ্ন জিজ্ঞাসা করার জন্য আমি আপনার সাথে দুইবার দেখা করব, একবার চিকিৎসা দেয়ার আগে এবং আবার ৪ সপ্তাহ পর। আপনাকে আশ্বস্ত করছি, চিকিৎসার ফলে আপনার কোনোরূপ ক্ষতি হবে না। আপনার দেওয়া তথ্য গোপন রাখা হবে এবং শুধুমাত্র থিসিসের উদ্দেশ্যে ব্যবহার করা হবে। যে কোনো সময় এই থিসিসে আপনার অংশগ্রহণ বন্ধ করার অধিকার রয়েছে।পাশাপাশি আপনি যদি কোন প্রশ্নের উত্তর দিতে অস্বস্তি বোধ করেন তবে আপনি সেই প্রশ্নটি এড়িয়ে যেতে পারেন। প্রশ্নাবলী পূরণ করতে ২০ থেকে ৩০ মিনিট সময় লাগবে। অনুগ্রহ করে আমাকে প্রশ্নগুলির সঠিক উত্তর দিন এবং আপনার স্বাস্থ্যের মূল্যায়ন করতে ডেটা সংগ্রহকারীকে যথাসাধ্য সহযোগিতা করুন। আপনার কোন প্রশ্ন থাকলে আমার সুপারভাইজার মুহাম্মদ মিল্লাত হোসেন, সহযোগী অধ্যাপক ও কোর্স সমন্বয়কারী, পুনর্বাসন বিজ্ঞান বিভাগ, বিএইচপিআই, সিআরপি, সাভার ঢাকা-১৩৪৩- এর সাথে যোগাযোগ করতে পারেন। আপনি যদি অনুগ্রহপূর্বক আপনার সম্মতি দেন, তবে আমরা শুরু করতে পারি।

হ্যাঁ না

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

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

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

গবেষকের স্বাক্ষর..... তারিখ.....

শিরোনাম

মেরুরজ্জুতে আঘাতপ্রাপ্ত রোগীদের দৈনন্দিন কার্যকলাপের মান উন্নয়নের জন্য কোর স্টেবিলাইজেশন ব্যায়ামের কার্যকারিতা

প্রশ্নাবলি (বাংলা)

রোগীর তথ্যাবলি

সাক্ষাতের তারিখ:

নাম:

আইডি নং: মোবাইল নং:

ঠিকানা: গ্রাম: পোস্টঅফিস:

থানা: বিভাগ:

পার্ট-১: সামাজিক-জনতাত্ত্বিক তথ্য

[সঠিক উত্তরে (√) চিহ্ন দিন]

নং	প্রশ্ন	উত্তর
১	বয়স:	_____ বছর
২	লিঙ্গ:	০= পুরুষ ১= মহিলা

নং	প্রশ্ন	উত্তর
৩	বৈবাহিক অবস্থা:	০= অবিবাহিত ১= বিবাহিত ২= তালাকপ্রাপ্ত ৩= বিধবা/বিপত্নীক
৪	বসবাসের এলাকা:	০= শহর ১= মফস্বল ২= গ্রাম
৫	শিক্ষাগত যোগ্যতা:	০= প্রতিষ্ঠানিক শিক্ষা নেই ১= প্রাথমিক ২= মাধ্যমিক ৩= উচ্চ-মাধ্যমিক ৪= স্নাতক ৫= স্নাতকোত্তর

৬	পেশা (মেরুরজ্জুতে আঘাতের আগে):	০= গৃহিনী ১= দোকানদার ২= কৃষক ৩= চাকুরিজীবি ৪= ব্যবসায়ি ৫= দিনমজুর ৬= ছাত্র ৭= বেকার ৮= অন্যান্য ----------
৭	পরিবারে সদস্য সংখ্যা:	
৮	পরিবারে উপার্জনকারীর সংখ্যা:	
৯	আর্থিক অবস্থা:	০= স্বনির্ভর ১= পরনির্ভর
১০	পরিবারের মাসিক খরচ:	
১১	মাসিক চিকিৎসা খরচ:	

পার্ট-২: মেরুরজ্জুতে আঘাত সম্পর্কিত প্রশ্নাবলি

নং.	প্রশ্ন	উত্তর
১২	আঘাতের পর প্রাপ্ত স্বাস্থ্য সেবা:	০= হাসপাতাল ১= থানা স্বাস্থ্য কেন্দ্র ২= বেসরকারি ক্লিনিক ৩= বাসায় চিকিৎসা নিয়েছি
১৩	আঘাতের পর বিশেষ স্বাস্থ্য সেবা:	০= নিউরোসাইন্স হাসপাতাল ১= সিআরপি ২= নিটোর ৩= অন্যান্য: _____
১৪	সিআরপিতে ভর্তির তারিখ:	___ / ___ / _____

নং.	প্রশ্ন	উত্তর
১৫	আঘাতের কারণ:	০= উচুঁ থেকে পড়ে ১= সড়ক দূর্ঘটনা ২= অগভীর পানিতে লাফ ৩= ওড়না পেচিয়ে আঘাত ৪= শারীরিক নির্যাতন ৫= মেরুরজ্জুতে টিউমার ৬= অন্যান্য আঘাতজনিত কারণ: _____ ৭= অন্যান্য রোগজনিত কারণ: _____
১৬	নিউরোলজিকাল লেভেল:	
১৭	স্কেলিটাল লেভেল:	
১৮	রোগ নির্ণয়:	০= ট্রমাটিক পেরাপ্লেজিয়া ১= ট্রমাটিক টেট্রাপ্লেজিয়া ২= নন-ট্রমাটিক পেরাপ্লেজিয়া 3= নন-ট্রমাটিক টেট্রাপ্লেজিয়া

নং.	প্রশ্ন	উত্তর
১৯	যে সব চিকিৎসা নেয়া হয়েছে:	০= কনজারভেটিভ ১= সার্জারি ২= সার্জারি এবং কনজারভেটিভ
২০	অন্যান্য রোগের সহাবস্থান (মেরুরজ্জুতে আঘাতের পরে):	০= চাপজনিত ঘা ১= দুশ্চিন্তা ২= অন্ত্র-মুত্রাশয়ের কর্মহিনতা ৩= শ্বাস-প্রশ্বাসজনিত সমস্যা ৪= অবস্থানগত নিম্ন-রক্তচাপ ৫= মুত্রাশয়ের শিথীলতা ৬= রক্তসঞ্চালনের সমস্যা ৭= পেশির শক্তভাব ৮= রোগ নেই ৯= একাধিক রোগ আছে

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

Patient Name_____ Date/Time of Exam _____

Examiner Name _____ Signature _____

RIGHT

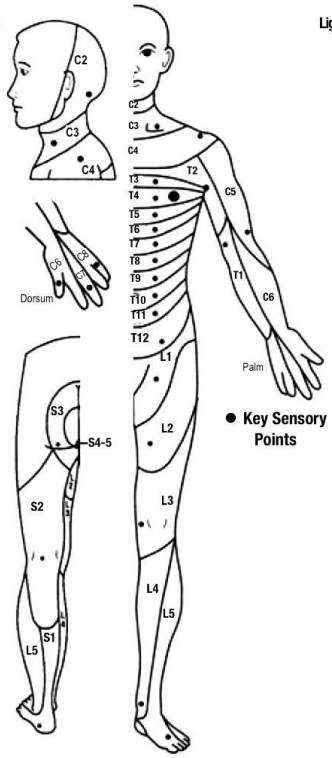
MOTOR KEY MUSCLES		SENSORY KEY SENSORY POINTS Light Touch (LTR)	Pin Prick (PPR)
	C2		
	C3		
	C4		
Elbow flexors	C5		
Wrist extensors	C6		
Elbow extensors	C7		
Finger flexors	C8		
Finger abductors (little finger)	T1		
	T2		
	T3		
	T4		
	T5		
	T6		
	T7		
	T8		
	T9		
	T10		
	T11		
	T12		
	L1		
Hip flexors	L2		
Knee extensors	L3		
Ankle dorsiflexors	L4		
Long toe extensors	L5		
Ankle plantar flexors	S1		
	S2		
	S3		
	S4-5		
RIGHT TOTALS (MAXIMUM)		(50)	(56)	(56)

UER (Upper Extremity Right)

LER (Lower Extremity Right)

Comments (Non-key Muscle? Reason for NT? Pain?):

(VAC) Voluntary Anal Contraction (Yes/No) ☐



● Key Sensory Points

LEFT

SENSORY KEY SENSORY POINTS Light Touch (LTL)	Pin Prick (PPL)	MOTOR KEY MUSCLES	
		C2	
		C3	
		C4	
		C5	Elbow flexors
		C6	Wrist extensors
		C7	Elbow extensors
		C8	Finger flexors
		T1	Finger abductors (little finger)
		T2	
		T3	
		T4	
		T5	
		T6	
		T7	
		T8	
		T9	
		T10	
		T11	
		T12	
		L1	
		L2	Hip flexors
		L3	Knee extensors
		L4	Ankle dorsiflexors
		L5	Long toe extensors
		S1	Ankle plantar flexors
		S2	
		S3	
		S4-5	
(56)	(56)	LEFT TOTALS (MAXIMUM)	(50)

UEL (Upper Extremity Left)

LEL (Lower Extremity Left)

MOTOR *(SCORING ON REVERSE SIDE)*

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
5* = normal corrected for pain/disuse
NT = not testable

SENSORY *(SCORING ON REVERSE SIDE)*

0 = absent 2 = normal
1= altered NT = not testable

☐ (DAP) Deep Anal Pressure (Yes/No)

MOTOR SUBSCORES

UER ☐ + UEL ☐ = *UEMS TOTAL* ☐ (50) — MAX (25) (25)

LER ☐ + LEL ☐ = *LEMS TOTAL* ☐ (50) — MAX (25) (25)

SENSORY SUBSCORES

LTR ☐ + LTL ☐ = *LT TOTAL* ☐ (112) — MAX (56) (56)

PPR ☐ + PPL ☐ = *PP TOTAL* ☐ (112) — MAX (56) (56)

NEUROLOGICAL LEVELS	R	L			
Steps 1-5 for classification as on reverse	1. SENSORY	☐	☐	3. NEUROLOGICAL LEVEL OF INJURY (NLI) ☐	4. COMPLETE OR INCOMPLETE? ☐ (Incomplete = Any sensory or motor function in S4-5)
	2. MOTOR	☐	☐		5. ASIA IMPAIRMENT SCALE (AIS) ☐

(In complete injuries only) **ZONE OF PARTIAL PRESERVATION** (Most caudal level with any innervation)

	R	L
SENSORY	☐	☐
MOTOR	☐	☐

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REV 11/15

পার্ট-৪: দৈনন্দিন কার্যকলাপ বিষয়ক প্রশ্নাবলি

(ব্যয়ামের আগে এবং ৪ সপ্তাহ পর তথ্য গ্রহন করা হয়েছে)

স্পাইনাল কর্ড ইনডিপেনডেন্স মেজার (স্কিম), হল একটি অক্ষমতা পরিমাপক স্কেল যা মেরুরজ্জুতে আঘাতপ্রাপ্ত রোগীদের জন্য বিশেষভাবে তৈরি করা হয়েছে যাতে ব্যক্তিগত পরিচর্যা, শ্বাস-প্রশ্বাস ও মাংসপেশি (মুত্রাশয়/মলদ্বার) পরিচালনা এবং চলনক্ষমতা (ঘরে এবং টয়লেটে) পরিমাপ করে দৈনন্দিন জীবনযাত্রার বিভিন্ন ক্রিয়াকলাপ এর মান মূল্যায়ন করা হয়।

ব্যক্তিগত পরিচর্যা	আইটেম স্কোর
১. খাওয়া (কাটাকুটি, কৌটা খোলা, পানি ঢালা, খাবার মুখের কাছে আনা, পানিসহ কাপ ধরা) ০= অন্য করো সাহায্য প্রয়োজন, গেস্ট্রটমি টিউব অথবা খাওয়ার জন্য সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= সামান্য সাহায্য অথবা সহায়ক উপকারনের সাহায্যে খাবার খেতে এবং পানি পান করতে পারে। ২= সহায়ক উপকারনের সাহায্যে নিজে নিজে খেতে পরে অথবা শুধুমাত্র কাটাকুটি, কৌটা খোলা, পানি ঢালার জন্য সাহায্যের প্রয়োজন হয়। ৩= সাহায্য এবং সহায়ক উপকরণ ছাড়াই, পানি ও খাবার নিজে নিজে খেতে পারে।	

২. গোসল করা (সাবান লাগানো, ধোয়া, মাথা ও শরীর মোছা, পানির কল ব্যবহার করা) **ক. শরীরের উপরের অংশ:** ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= সামান্য সাহায্যের প্রয়োজন হয়। ২= গোসল করার জন্য সহায়ক উপকরণ অথবা রূপান্তরিত কোনো জায়গার(যেমন: চেয়ার) প্রয়োজন হয়। ৩= গোসল করার জন্য সহায়ক উপকরণ অথবা রূপান্তরিত কোনো জায়গার(যেমন: চেয়ার) প্রয়োজন হয় না।	
খ. শরীরের নিচের অংশ ধোঁয়া ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= সামান্য সাহায্যের প্রয়োজন হয়। ২= গোসল করার জন্য সহায়ক উপকরণ অথবা রূপান্তরিত কোনো জায়গার(যেমন: চেয়ার) প্রয়োজন হয়। ৩= গোসল করার জন্য সহায়ক উপকরণ অথবা রূপান্তরিত কোনো জায়গার(যেমন: চেয়ার) প্রয়োজন হয় না।	

৩. জামাকাপড় পড়া (জামা, জুতা, পরিবর্তন করা যায় না এমন অর্থসিস- পড়া এবং খোলা) **ক. শরীরের উপরের অংশ:** ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= বোতাম, চেইন অথবা ফিতা ছাড়া জামাকাপড় পড়তে সামান্য সাহায্যের প্রয়োজন হয়। ২= বোতাম, চেইন অথবা ফিতা ছাড়া জামাকাপড় পড়তে সহায়ক উপকরন অথবা রূপান্তরিত কোনো জায়গার প্রয়োজন হয়। ৩= সহায়ক উপকরন অথবা রূপান্তরিত কোনো জায়গা ছাড়াই- বোতাম, চেইন অথবা ফিতা ছাড়া জামাকাপড় নিজে পড়তে পারে কিন্তু বোতাম, চেইন অথবা ফিতা লাগাতে সাহায্য ও সহায়ক উপকরণ অথবা বিশেষ জায়গার প্রয়োজন হয়। ৪= সহায়ক উপকরন অথবা রূপান্তরিত কোনো জায়গা ছাড়াই নিজে নিজে যেকোনো জামাকাপড় পড়তে পারে।	

খ. শরীরের নিচের অংশ: ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= বোতাম, চেইন অথবা ফিতা ছাড়া জামাকাপড় পড়তে সামান্য সাহায্যের প্রয়োজন হয়। ২= বোতাম, চেইন অথবা ফিতা ছাড়া জামাকাপড় পড়তে সহায়ক উপকরন অথবা রূপান্তরিত কোনো জায়গার প্রয়োজন হয়। ৩= সহায়ক উপকরন অথবা রূপান্তরিত কোনো জায়গা ছাড়াই- বোতাম, চেইন অথবা ফিতা ছাড়া জামাকাপড় নিজে পড়তে পারে কিন্তু বোতাম, চেইন অথবা ফিতা লাগাতে সাহায্য ও সহায়ক উপকরণ অথবা বিশেষ জায়গার প্রয়োজন হয়। ৪= সহায়ক উপকরন অথবা রূপান্তরিত কোনো জায়গা ছাড়াই নিজে নিজে যেকোনো জামাকাপড় পড়তে পারে।	

৪. পরিষ্কার- পরিচ্ছন্নতা (হাত- মুখ ধোয়া, দাঁত ব্রাশ করা, চুল আচড়ানো, শেভ করা, মেকআপ লাগানো) ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= সামান্য সাহায্যের প্রয়োজন হয়। ২= সহায়ক উপরকরণের সাহায্যে নিজে নিজে পরিষ্কার হতে পারি। ৩= সহায়ক উপরকরণের সাহায্যে ছাড়া নিজে নিজে পরিষ্কার হতে পারি।	

ব্যক্তিগত পরিচর্যার সাবটোটাল (০-২০)	

শ্বাস-প্রশ্বাস ও মাংসপেশি (মুত্রাশয়/মলদ্বার) পরিচালনা	আইটেম স্কোর
৫. শ্বাস-প্রশ্বাস ০= সব সময় অথবা মাঝে মাঝে শ্বাস- প্রশ্বাস গ্রহণের জনি কৃত্রিম শ্বাসনালী (ট্রাকিয়াল টিউব) প্রয়োজন হয়। ২= শ্বসনালী তে লাগানো টিউবের মাধ্যমে সঠিকভাবে নিজে নিজে শ্বাস নিতে পারে, অক্সিজেন প্রয়োজন হয়, কাশি এবং শ্বাসনালির টিউব পরিচালনার জন্য সাহায্যের প্রয়োজন হয়। ৪= শ্বসনালী তে লাগানো টিউবের মাধ্যমে সঠিকভাবে নিজে নিজে শ্বাস নিতে পারে, অক্সিজেন প্রয়োজন হয়, কাশি এবং শ্বাসনালির টিউব পরিচালনার জন্য অল্প সাহায্যের প্রয়োজন হয়। ৬= টিউব ছাড়া শ্বসনালীর মাধ্যমে সঠিকভাবে নিজে নিজে শ্বাস নিতে পারে, অক্সিজেন প্রয়োজন হয়, কাশি এবং শ্বাসনালির টিউব পরিচালনার জন্য পর্যাপ্ত সাহায্যের প্রয়োজন হয়। ৮= শ্বসনালীর মাধ্যমে সঠিকভাবে নিজে নিজে শ্বাস নিতে পারে, অক্সিজেন প্রয়োজন হয়, কাশি এবং শ্বাসনালির টিউব পরিচালনার জন্য সামান্য সাহায্যের প্রয়োজন হয়। ১০= কোন প্রকার সাহায্য ছাড়াই শ্বাস নিতে পরে।	

৬. মাংসপেশি (মুত্রাশয়) পরিচালনা ০= অন্তরবর্তী কেথেটারের প্রয়োজন হয়। ৩= রিসিডিউয়াল ইউরিন ভলিউম- ১০০ সিসি এর চেয়ে বেশি, মাঝে মাঝে কেথেটারের প্রয়োজন হয়। ৬= রিসিডিউয়াল ইউরিন ভলিউম- ১০০ সিসি এর চেয়ে কম, মাঝে মাঝে নিজে কেথেটার করে, মূত্র নিষ্কাষনের জন্য সহায়ক কৃত্রিম নলের প্রয়োজন হয়। ৯= মাঝে মাঝে নিজে কেথেটার করে, মূত্র নিষ্কাষনের জন্য সহায়ক কৃত্রিম নলের প্রয়োজন হয় না। ১১= মাঝে মাঝে নিজে কেথেটার করে, কেথেটারাইজেশনের বিরতি তে মূত্র ধরে রাখতে পারে, মূত্র নিষ্কাষনের জন্য সহায়ক কৃত্রিম নলের প্রয়োজন হয় না। ১৩= রিসিডিউয়াল ইউরিন ভলিউম- ১০০ সিসি এর চেয়ে কম, মূত্র নিষ্কাষনের জন্য সহায়ক কৃত্রিম নলের প্রয়োজন হয় না কিন্তু বাইরে মূত্র নিষ্কাশনের প্রয়োজন হয়। ১৫= রিসিডিউয়াল ইউরিন ভলিউম- ১০০ সিসি এর চেয়ে কম, মূত্রের বেগ ধারনে সক্ষম, মূত্র নিষ্কাষনের জন্য সহায়ক কৃত্রিম নলের প্রয়োজন হয় না।	

৭. **মাংসপেশি (মলদ্বার) পরিচালনা** ০= অনিয়মিতভাবে অথবা হঠাৎ (৩ দিনে একবার) মলত্যাগ করতে পারে। ৫= নিয়মিত ভাবে হয়ে থাকে, কিন্তু কিছু সাহায্যের প্রয়োজন হয়, খুব কম দুর্ঘটনা ঘটে থাকে (১মাসে দুইবারের কম) ৮= কোনো সাহায্য ছাড়াই মলত্যাগ হয়, খুব কম দুর্ঘটনা ঘটে থাকে (১মাসে দুইবারের কম) ১০= দুর্ঘটনা ও সাহায্য ছাড়াই নিয়মিত মলত্যাগ করতে পারে।	
৮. **টয়লেটের ব্যবহার** (মলদ্বার পরিষ্কার করা, মলত্যাগের আগে জামাকাপড় সঠিকভাবে পরিধান করা ও খোলা, ন্যাপকিন অথবা ডায়পার এর ব্যবহার) ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= সামান্য সাহায্য প্রয়োজন হয়, নিজে নিজে পরিষ্কার হতে পারে না। ২= সামান্য সাহায্য প্রয়োজন হয়, নিজে নিজে পরিষ্কার হতে পারে। ৪= নিজে নিজে টয়লেট ব্যবহার করতে পারে কিন্তু সহায়ক উপকরণ অথবা রূপান্তরিত টয়লেট প্রয়োজন হয়। ৫= নিজে নিজে টয়লেট ব্যবহার করতে পারে এবং সহায়ক উপকরণ অথবা রূপান্তরিত কোনো জায়গার প্রয়োজন হয় না।	

শ্বাস-প্রশ্বাস ও মাংসপেশি (মুত্রাশয়/মলদ্বার) পরিচালনা সাবটোটাল (০-৪০)	

চলাচল (ঘরে এবং টয়লেটে)	**আইটেম স্কোর**
৯. বিছানায় পাশ পরিবর্তন এবং চাপজনিত ঘা প্রতিরোধে করণীয় কাজ ০= সব কাজে সাহায্যের প্রয়োজন হয় (শরীরের উপরের অংশ ও নিচের অংশ নড়চড় করার জন্য, বিছানায় বসার জন্য, হুইলচেয়ারে বসে ধাক্কা দিয়ে নিজের শরীর তোলার জন্য সহায়ক উপকরণ সহ অথবা ছাড়া কিন্তু কোনো বৈদ্যুতিক উপকরণ দ্বারা নয়)। ২= যেকোনো একটা কাজ সাহায্য ছাড়া করতে পারে। ৪= যেকোনো দুইটা/তিনটা কাজ করতে পারে। ৬= বিছানায় সব রকমের পাশ পরিবর্তন অথবা ঘা প্রতিরোধে সকল কাজ সাহায্য ছাড়াই করতে পারে।	
১০. জায়গা পরিবর্তন: বিছানা-হুইলচেয়ার (হুইলচেয়ার লক করা, ফুটরেস্ট সরানো, হাতল সরানো ও ঠিক জায়গায় রাখা, স্থানান্তর, পা উপরে তোলা) ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= সামান্য সাহায্যের প্রয়োজন হয় অথবা নজরদারি অথবা সহায়ক উপকরণ (যেমন: কাঠের বোর্ড) প্রয়োজন হয়। ২= স্বাধীনভাবে চলাচল করতে পারে (হুইলচেয়ার প্রয়োজন হয় না)	

১১. জায়গা পরিবর্তন: হুইলচেয়ার থেকে টয়লেট (যদি টয়লেট থেকে হুইলচেয়ার ব্যবহার করে তাহলে স্থানান্তর হওয়া- হুইলচেয়ার অথবা হুইলচেয়ারে অথবা হুইলচেয়ার থেকে, সাধারণ হুইলচেয়ার ব্যবহারকারীর ক্ষেত্রে- হুইলচেয়ার লক করা, ফুটোরেস্ট সরানো, হাতল সরানো ও ঠিক জায়গায় রাখা, স্থানান্তর হওয়া, পা উপরে তোলা) ০= সম্পূর্ণ সাহায্যের প্রয়োজন। ১= সামান্য সাহায্যের প্রয়োজন হয় অথবা নজরদারি অথবা সহায়ক উপকরণ (যেমন: ধরার জন্য উপকরণ) প্রয়োজন হয়। ২= স্বাধীনভাবে চলাচল করতে পারে (হুইলচেয়ার প্রয়োজন হয় না)।	
১৩. সীমিত বা মাঝারি দূরত্বে চলাচল (১০-১০০ মিটার) ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= বৈদ্যুতিক হুইলচেয়ার লাগে অথবা হাত দিয়ে চালানো হুলোচেয়ার চালাতে সামান্য সাহায্য প্রয়োজন হয়। ২= হাত দিয়ে চালানো হুইলচেয়ারের মাধ্যমে নিজে নিজে চলাচল করতে পারে। ৩= কোনো উপকরণ সহ অথবা ছাড়া হাঁটার সময় নজরদারি প্রয়োজন হয়। ৪= হাঁটার জন্য ব্যবহৃত ফ্রেম/ক্রাচ দিয়ে হাঁটতে পারে। ৫= ক্রাচ অথবা হাঁটার জন্য ব্যবহৃত দুটি লাঠির সাহায্যে হাঁটতে পারে।	

৬= হাঁটার জন্য ব্যবহৃত একটি লাঠির সাহায্যে হাঁটতে পারে। ৭= শুধু পায়ের জন্য অর্থসিস প্রয়োজন হয়। ৮= কোনো প্রকার হাঁটার উপকরণ ছাড়াই হাঁটতে পারে।	
১৫. সিঁড়িতে চলাচল ০= সিঁড়িতে উঠতে এবং নামতে পারে না। ১= অন্যকারো সাহায্য নিয়ে অথবা নজরদারি র মাধ্যমে কমপক্ষে সিঁড়ির তিনটি ধাপ উঠা-নামা করতে পারে। ২= সিঁড়ির হাতল/ক্রাচ/হাঁটার জন্য ব্যবহৃত লাঠির মাধ্যমে কমপক্ষে তিনটি সিঁড়ির ধাপ উঠানামা করতে পারে। ৩= অন্যকারো সাহায্য ছাড়াই কমপক্ষে সিঁড়ির তিনটি ধাপ উঠা-নামা করতে পারে।	
১৬. জায়গা পরিবর্তন/স্থানান্তর: হুইলচেয়ার থেকে গাড়ি (গাড়ির কাছাকাছি যেতে পারে, হুইলচেয়ার লক করা, ফুটোরেস্ট সরানো, হাতল সরানো ও ঠিক জায়গায় রাখা, গাড়ি থেকে স্থানান্তর, হুইলচেয়ার গাড়ির ভেতরে ও বাইরে নেয়া) ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= সামান্য সাহায্যের প্রয়োজন হয় অথবা নজরদারি অথবা সহায়ক উপকরণ (যেমন: ধরার জন্য উপকরণ) প্রয়োজন হয়। ২= স্বাধীনভাবে চলাচল করতে পারে (হুইলচেয়ার প্রয়োজন হয় না)	

১৭. জায়গা পরিবর্তন/স্থানান্তর: মেঝে থেকে হুইলচেয়ার ০= সম্পূর্ণ সাহায্যের প্রয়োজন হয়। ১= নিজে স্থানান্তর হতে পারে, সহায়ক উপকরণ প্রয়োজন নেই।	

চলাচল সাবটোটাল (০-৪০)	

মোট স্কিম স্কোর (০-১০০)	**প্রি-টেস্ট: _____**

Informed Consent

Greetings!

My name is Mahdi Ul Bari. I am conducting this study which is part of my course curriculum, and my thesis title is **"Effectiveness of Core Stabilization Exercises for Functional Improvement of Spinal Cord Injury (SCI) Patients"**. For the fulfillment of my study, I would like to know some information about social, demographics, clinical information set people. So, I need to ask you some questions and examine you on this regard and this will take approximately 20 to 30 minutes.

I assure you that this is pure professional study, and this will not be creating any harm to you. The information you will provide will be treated as confidential and in the event of any report or publication the source of this information will be kept anonymous. I would like to inform you that your participation in this study will be considered as voluntary and there will not be any kind of financial dealings.

As a part of this study or by the rights of the participants you can withdraw yourself at any time from this study or if you will want to skip any questions that you don't want to give answer, you can proceed. If you further have any questions on this study, please feel free to ask researcher Mahdi Ul Bari, 4th year student, Physiotherapy Department, Bangladesh Health Professions Institute (BHPI), CRP, Savar, Dhaka- 1343 or my research supervisor Muhammad Millat Hossain, Associate Professor & Course Coordinator, Department of Rehabilitation Science, BHPI.

May I start the interview? (Put tick mark)

Yes No

Signature of the Participant's: Date:

Signature of Interviewer: Date:

Signature of Witness: Date:

Research Title

Effectiveness of Core Stabilization Exercises for Functional Improvement of Spinal Cord Injury (SCI) Patients

Questionnaires:

Date of interview:

Patient's name:

Patient's ID: Patient's Mobile No:

Patient's address: Village: P.O:

P.S: District:

Part-I: Socio-Demographic Information

[Use tick (√) to mark the correct answer]

No.	Question	Response
1	Age:	_____ years
2	Gender:	0=Male 1=Female
3	Marital status:	0=Unmarried 1=Married 2=Divorced 3=Widow

No.	Question	Response
4	Living area:	0= Urban 1= Semi-urban 2= Rural
5	Educational level:	0= No formal education 1= Primary 2= Secondary 3= Higher Secondary 4= Graduate 5= Postgraduate 6= Master's
6	Occupation/Profession (before SCI):	0= Housewife 1= Shopkeeper 2= Farmer 3= Service holder 4= Business 5= Day-labourer 6= Student 7= Unemployed 8= Others
7	The number of family members:	
8	The number of earning members in the family:	
9	Financial condition:	0= Independent 1= Dependent
10	Family expense:	

11	Monthly treatment expense:	

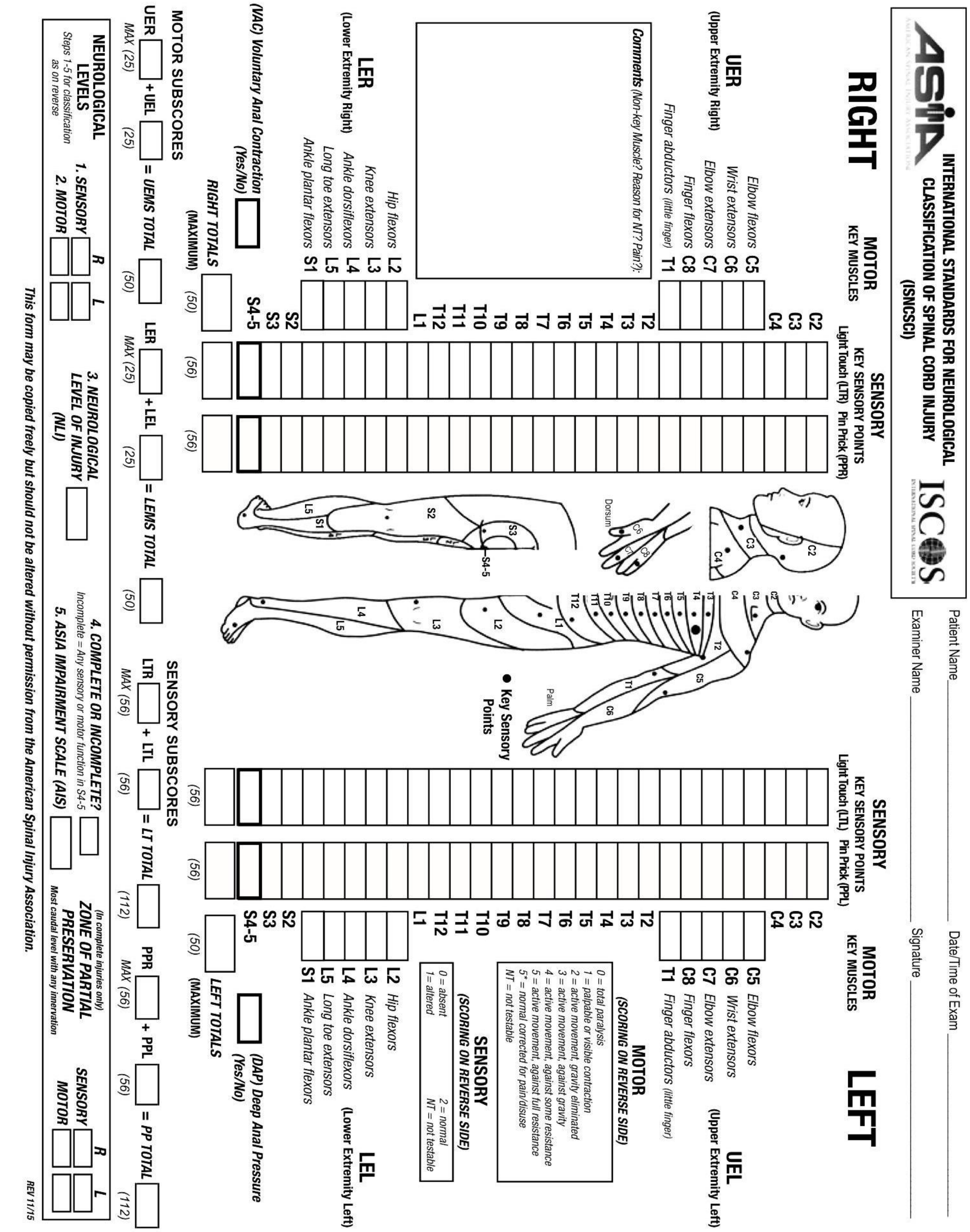
Part-II: Clinical information

No.	Question	Response
12	Health care received after trauma:	0= Hospital 1= Thana health complex 2= Private clinic 3= Home
13	Name of the facility where healthcare was received after trauma or injury:	0= NINS 1= CRP 2= NITOR 3= Others: _____
14	Admission date at CRP:	___ / ___ / _____

No.	Question	Response
15	Causes of injury:	0= Fall from height 1= Road traffic accident 2= Shallow water diving 3= Scarf injury 4= Physical assault 5= Spinal tumor 6= Other traumatic causes: _____ 7= Other non-traumatic causes: _____
16	Neurological level:	
17	Skeletal level:	
18	Diagnosis:	0= Traumatic paraplegia 1= Traumatic tetraplegia 2= Non-traumatic paraplegia 3= Non-Traumatic tetraplegia

No.	Question	Response
19	Treatment received:	0= Conservative 1= Surgery 2= Surgery and conservative
20	Comorbidity (Before SCI):	0= Heart disease 1= High blood pressure 2= Respiratory diseases 3= Diabetes 4= Ulcer and stomach disease 5= Kidney disease 6= Liver disease 7= Anaemia or other blood disease 8= None
21	Comorbidity (After SCI)	0= Pressure sore 1= Depression 2= Bowel bladder dysfunction 3= Respiratory complication 4= Postural hypotension 5= Urinary incontinence 6= Circulatory problem 7= Spasticity 8= None

Part-III: Clinical examination



Part-IV: Functional examination

(Data was taken before and after 4 weeks of intervention)

The Spinal Cord Independence Measure (SCIM), is a disability scale developed specifically for the SCI population to assess various activities of daily living (ADLs) by measuring self-care, respiratory and sphincter management & mobility (room and toilet).

Self Care	Item score
1. Feeding (cutting, opening containers, pouring, bringing food to mouth, holding cup with fluid) 0= Needs parenteral, gastrostomy or fully assisted oral feeding. 1= Needs partial assistance for eating and/or drinking, or for wearing adaptive devices 2= Eats independently; needs adaptive devices or assistance only for cutting food and/or pouring and/or opening containers 3= Eats and drinks independently; does not require assistance or adaptive devices	

2. Bathing (soaping, washing, drying body and head, manipulating water tap) **A. Upper body:** 0= Requires total assistance 1= Requires partial assistance 2= Washes independently with adaptive devices or in a specific setting (e.g., bars, chair) 3= Washes independently; does not require adaptive devices or specific setting (not customary for healthy people)	
B. Lower body 0= Requires total assistance 1= Requires partial assistance 2= Washes independently with adaptive devices or in a specific setting (adss) 3= Washes independently; does not require adss	

3. Dressing (clothes, shoes, permanent orthoses; dressing, wearing, undressing) **A. Upper body** 0= Requires total assistance 1= Requires partial assistance with clothes without buttons, zippers or laces (cwobzl) 2= Independent with cwobzl; requires adaptive devices and/or specific settings (adss) 3. Independent with cwobzl; does not require adss; needs assistance or adss only for buttons, zippers or laces (bzl) 4. Dresses (any clothes) independently; does not require adaptive devices or specific setting	

B. Lower body 0= Requires total assistance 1= Requires partial assistance with clothes without buttons, zippers or laces (cwobzl) 2= Independent with (cwobzl), requires adaptive devices and/or specific settings (adss) 3= Independent with cwobzl without adss needs assistance or adss only for bzl 4= Dresses (any clothes) independently does not require adaptive devices or specific setting	
4. Grooming (washing hands and face, brushing teeth, combing hair, shaving, applying makeup) 0= Requires total assistance 1= Requires partial assistance 2= Grooms independently with adaptive devices 3= Grooms independently without adaptive devices	

Self Care Subtotal (0-20)	

Respiration and Sphincter Management	Item score
5. Respiration 0= Requires tracheal tube (TT) and permanent or intermittent assisted ventilation (IAV) 2= Breathes independently with TT; requires oxygen, much assistance in coughing or TT management 4= Breathes independently with TT; requires little assistance in coughing or TT management 6= Breathes independently without TT; requires oxygen, much assistance in coughing, a mask (e.g., peep) or IAV 8= Breathes independently without TT; requires little assistance or stimulation for coughing 10= Breathes independently without assistance or device	

6. **Sphincter Management - Bladder** 0= Indwelling catheter 3= Residual urine volume (RUV) > 100cc; no regular catheterization or assisted intermittent catheterization 6= RUV < 100cc or intermittent self-catheterization; needs assistance for applying drainage instrument 9= Intermittent self-catheterization; uses external drainage instrument; does not need assistance for applying 11= Intermittent self-catheterization; continent between catheterizations; does not use external drainage instrument 13= RUV <100cc; needs only external urine drainage; no assistance is required for drainage 15= RUV <100cc; continent; does not use external drainage instrument	

7. **Sphincter Management - Bowel** 0= Irregular timing or very low frequency (less than once in 3 days) of bowel movements 5= Regular timing, but requires assistance (e.g., for applying suppository); rare accidents (less than twice a month) 8= Regular bowel movements, without assistance; rare accidents (less than twice a month) 10= Regular bowel movements, without assistance; no accidents	

8. **Use of toilet** (perineal hygiene, adjustment of clothes before/after, use of napkins or diapers) 0= Requires total assistance 1= Requires partial assistance; does not clean self 2= Requires partial assistance; cleans self independently 4= Uses the toilet independently in all tasks but needs adaptive devices or special setting (e.g., bars) 5= Uses toilet independently; does not require adaptive devices or special setting	

Respiration and Sphincter Management Subtotal (0-40)	

Mobility (room and toilet)	Item score
9. **Mobility in Bed and Action to Prevent Pressure Sores** 0= Needs assistance in all activities: turning upper body in bed, turning lower body in bed, sitting up in bed, doing push-ups in wheelchair, with or without adaptive devices, but not with electric aids 2= Performs one of the activities without assistance 4= Performs two or three of the activities without assistance 6= Performs all the bed mobility and pressure release activities independently 10= Breathes independently without assistance or device	
10. **Transfers: bed-wheelchair** (locking wheelchair, lifting footrests, removing and adjusting arm rests, transferring, lifting feet) 0= Requires total assistance 1= Needs partial assistance and/or supervision, and/or adaptive devices (e.g., sliding board) 2= Independent (or does not require wheelchair)	

11. **Transfers: wheelchair-toilet-tub** (if uses toilet wheelchair: transfers to and from; if uses regular wheelchair: locking wheelchair, lifting footrests, removing and adjusting armrests, transferring, lifting feet) 0= Requires total assistance 1= Needs partial assistance and/or supervision, and/or adaptive devices (e.g., grab-bars) 2= Independent (or does not require wheelchair)	
13. **Mobility for Moderate Distances (10-100 metres)** 0=Requires total assistance 1= Needs electric wheelchair or partial assistance to operate manual wheelchair 2= Moves independently in manual wheelchair 3= Requires supervision while walking (with or without devices) 4= Walks with a walking frame or crutches (swing) 5= Walks with crutches or two canes (reciprocal walking) 6= Walks with one cane 7= Needs leg orthosis only 8= Walks without walking aids	

14. **Mobility Outdoors (more than 100 metres)** 0= Requires total assistance 1= Needs electric wheelchair or partial assistance to operate manual wheelchair 2= Moves independently in manual wheelchair 3= Requires supervision while walking (with or without devices) 4= Walks with a walking frame or crutches (swing) 5= Walks with crutches or two canes (reciprocal waking) 6= Walks with one cane 7= Needs leg orthosis only 8= Walks without walking aids	

15. **Stair Management** 0= Unable to ascend or descend stairs 1=Ascends and descends at least 3 steps with support or supervision of another person 2= Ascends and descends at least 3 steps with support of handrail and/or crutch or cane 3= Ascends and descends at least 3 steps without any support or supervision	
16. **Transfers: wheelchair-car** (approaching car, locking wheelchair, removing arm and footrests, transferring to and from car, bringing wheelchair into and out of car) 0= Requires total assistance 1= Needs partial assistance and/or supervision and/or adaptive devices 2= Transfers independent; does not require adaptive devices (or does not require wheelchair)	

17. **Transfers: ground-wheelchair** 0= Requires assistance 1= Transfers independent with or without adaptive devices (or does not require wheelchair)	

Mobility Subtotal (0-40)	

TOTAL SCIM SCORE (0-100)	**Pretest: _____**

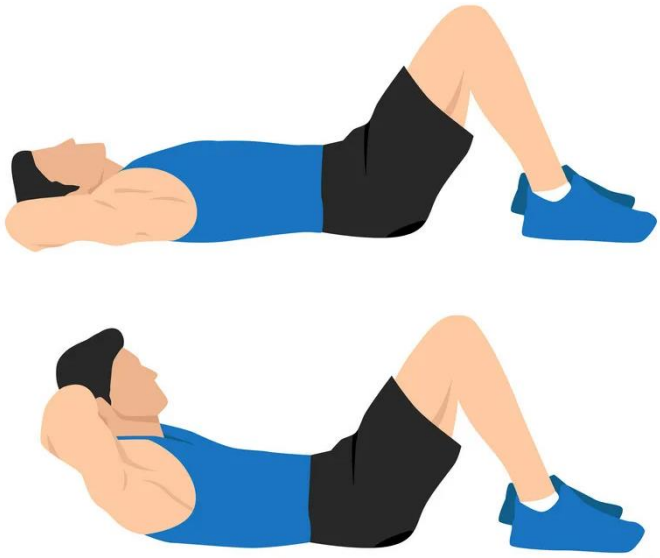
গবেষণার শিরোনাম

মেরুরজ্জুতে আঘাতপ্রাপ্ত রোগীদের দৈনন্দিন কার্যকলাপের মান উন্নয়নের জন্য কোর স্টেবিলাইজেশন ব্যায়ামের কার্যকারিতা

ব্যায়াম সম্পর্কিত নির্দেশনাবলিঃ

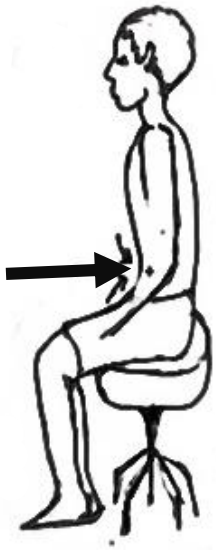
১। ক্রাঞ্চ

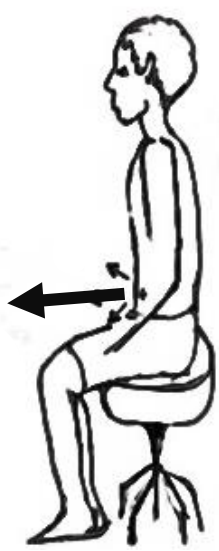
- চিত হয়ে শুয়ে পড়ুন।
- হাটু ভাজ করুন।
- দুই হাত দিয়ে মাথার পিছনে স্পর্শ করুন।
- শ্বাস নিন এবং পেটের মাংশপেশি ব্যবহার করে শরীরের উপরের অংশ উপরের দিকে তুলে নিয়ে আসুন।
- উপরে উঠে আসার সময় আপনার মাথা সোজা রাখুন।
- আস্তে আস্তে শ্বাস ছাড়ুন এবং নিচে নেমে আসুন।
- ব্যায়ামটি ১০ বার করে দিনে ৪ বার করুন।



২। এবডমিনাল ড্রয়িং-ইন মেন্যুভার

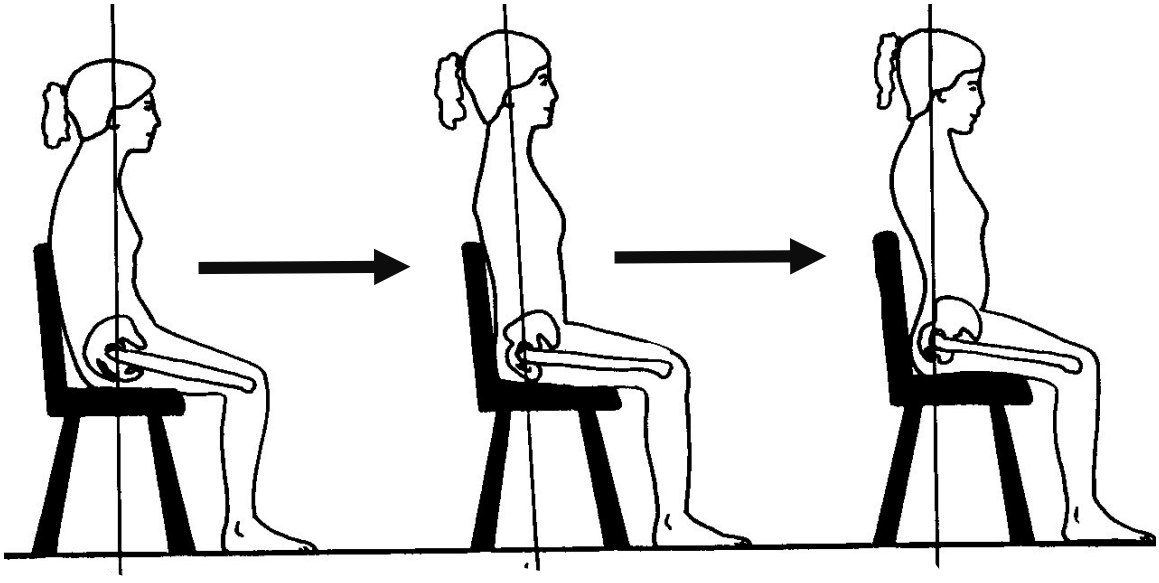
- পিঠ টানটান করে বসে পড়ুন
- আস্তে আস্তে পেটের মাংসপেশি ভেতরের দিকে সংকুচিত করুন
- সংকুচিত অবস্থায় ১০ সেকেন্ড ধরে রাখুন তারপর ছেড়ে দিন।
- ব্যায়ামটি ১০ বার করে দিনে ৩ বার করুন।





৩। এন্টেরিয়র-পোস্টেরিয়র পেলভিক টিল্ট

- টান টান হয়ে বসুন
- দুই হাত হাটুর উপরে রাখুন
- মাথা এবং শরীরের উপরের অংশ সোজা রেখে কোমড় এবং মেরুদন্ড কিঞ্চিত সামনের দিকে বাঁকা করুন। ৫ সেকেন্ড ধরে রাখুন।
- একই ভাবে কোমড় এবং মেরুদন্ড কিঞ্চিত পেছন দিকে বাঁকা করুন। ৫ সেকেন্ড ধরে রাখুন।
- ব্যায়ামটি ১০ বার করে দিনে ৩ বার করুন।



৪। **ক্লেম্পশেল**

- কাত হয়ে শুয়ে পড়ুন।
- মাথার নিচে হাত দিয়ে দিন এবং অপর হাত দিয়ে কোমড় স্পর্শ করুন।
- হাটু ৯০° ভাজ করুন।
- দুই পায়ের পাতা একত্রে রেখে উপরের হাটু উপরের দিকে তুলুন। ৫ সেকেন্ড ধরে রাখুন।
- একইভাবে অপর পার্শ্বে ব্যয়াম করুন। ৫ সেকেন্ড ধরে রাখুন।
- ব্যয়ামটি ১০ বার করে দিনে ৩ বার করুন।