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Research Article

Profiles, Neuromotor Recovery and Functional Performance of Survivors of Acute Traumatic Spinal Cord Injury: A 24-Week Observational Study

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ABSTRACT
Despite global disability from traumatic spinal cord injury (TSCI) especially in Low-and-Middle-Income countries, there is dearth of literature on clinical profile and recovery pattern of its survivors. Hence, this study did this over a 2-year post-TSCI. Twenty-nine (20males) TSCI survivors who reported to tertiary health facilities within 6hours of injury between December 2018 and March 2020 were profiled within 24hours. TSCI-severity was assessed using American-Spinal Injury Association-scale; Functioning using Spinal Cord Independence-Measure, walking function using Walking-Index and neuro-muscular recovery using Neuromuscular Recovery-Scale, every 6-weeks for 6-months. Participants aged 15-58years (mean=36.75±11.75years; mode=35years). TSCI occurred most from Road-crash (65.5%) and among passengers of commercial vehicles (73.7%). It occurred more in cervical-spine (62.1%) resulting in quadriplegia/paresis, lumbar-spine (27.5%) and thoracic-spine (10.4%) causing paraplegia/paraparesis. More (31.0%) had ASIA-A and ASIA–C each, 24.2% had ASIA-B, while 13.8% had ASIA-D. Functional performance and Neuromuscular Recovery improved significantly ($p<0.05$) in all domains except open-with-key and sit-to-stand domains. Traumatic spinal cord injury is common in males of productive age and affects more cervical spine resulting in quadriplegia/quadriparesis. Individual with spinal cord injury had steady significant neuromotor and functional recovery over 6-month after the injury. Early and comprehensive Physiotherapy is key for functional recovery in TSCI.

Keywords: *Spinal Cord Injury, Neuromotor Recovery, Functional Performance, Rehabilitation, Survivors*

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INTRODUCTION

Spinal cord injury is a global phenomenon with greater impact on the low- and middle-income countries. Spinal cord injury affects neural structures as well as other major organs and systems whose functions depend on central nervous system functions. Traumatic spinal cord injury (TSCI) especially at the cervical level, is a multisystem physiological impairment rather than just damage to the spine (Calvert *et al*, 2019; Udoh and Obeta, 2019; Banita *et al*, 2021). This multiple organ susceptibility poses the greatest risk of death during the acute period and possibly some few weeks after (Kumar *et al*, 2017; Nasidi *et al*, 2019).

Although socio-demographic and clinical characteristics among population of spinal cord injury survivors have been reported severally, there is dearth of contributing literature from developing nations. Despite the global disability associated with TSCI and the peculiarity in the Low-and-Middle-Income countries, there is dearth of literature on clinical profile and recovery pattern of its survivors over a long period to substantiate the pattern of recovery function and return to independent lifestyle in them. Even with the available data from developed countries, there exists variability predicated on cultural, social, economic, and environmental characteristics (Udoh and Obeta, 2019). Spinal cord injury is peculiar as it has a cascade of consequences that impact negatively on several aspects of life of both the survivors and the informal caregivers. It has negative impacts on physical independent functioning, productivity as well as economic burden on the families and society (Lofvenmark *et al*, 2015; Chin 2018), impacting negatively on all aspects of life (Middleton *et al*, 2012; Lee *et al*, 2014; Banita *et al*, 2021) and imposes a considerable economic burden on their families and society (Ahuja *et al*, 2017).

Although current clinical management of most spinal cord injury is largely supportive as there is not yet a cure for a severely damaged spinal cord, early commencement of neuro-rehabilitation and anticipation of supportive needs during recovery becomes pertinent in the management of individuals with spinal cord injury for independent functional performance and to reduce burden of care on the informal caregivers. This is effective not only in spinal cord injury but in any neurological disorder in reducing morbidity and improving function (Herzer *et al*, 2016; Sanivarapu *et al*, 2016; Oyewole *et al*, 2017; Olawale 2021). In spinal cord injury, this early intervention results in neuromuscular recovery measured by degree of restoration of neuromuscular integrity and possible return to functioning. Sequel to spinal cord injury, especially in the first-year post injury, the human central nervous system is capable of considerable plasticity, and the degrees and extent of neuroplasticity and recovery depend on factors including level and extent of injury, post-injury medical and surgical care, rehabilitative intervention strategies and family and social support (Sanivarapu *et al*, 2016).

After TSCI, the patient experiences immense social pressure to attain an upright posture and walk again as well as to return to their pre-morbid activity of daily living (Lofvenmark, *et al*, 2015; Drazin and Boakye, 2016). Therefore, recovery of walking is an important goal of the rehabilitation programme for individuals with spinal cord injury (Lofvenmark, *et al*, 2015; Drazin and Boakye, 2016, Chin 2018, Mekki *et al*, 2018). The achievement of this is associated with improved quality of life, socio-economic value and psychologically benefits them and their families (Harkema *et al*, 2012; Gbiri *et al*, 2015; Nasidi *et al*, 2019). The benefits of being able to walk again has positive impact on psychological and mental wellbeing of both the patient and their informal caregivers and preventing complications like spasticity, indigestion, prevention of pressure sores and most importantly, reducing dependency and increased productivity (Gbiri *et al*, 2015; Lofvenmark *et al*, 2015; Calvert *et al*, 2019). Other physiological benefits of walking to the patient with TSCI are prevention of heterotrophic ossification, prevention of osteoporosis, improved blood circulation, improved postural sensibility and vasomotor control, hence reducing complications that are frequently associated with TSCI (Lofvenmark *et al*, 2015; Rejc *et al*, 2017).

Given the peculiarity of individuals with spinal cord injury and the life of spinal cord injury survivors, it is important to profile them from acute phase of the injury through a specific period in which they would have recovered functional independence. This would help in projecting the recovery pattern of people with spinal cord injury and project for their possible needs at later stage of their recovery as early as the acute phase of the injury. Hence, this study documented socio-demographic and clinical profiles of individuals with TSCI in Lagos state Nigeria who accessed healthcare services immediately after their spinal cord injury and presents the pattern of their neuro-motor recovery, functional performance and regaining and returning of walking function over a two-year period.

MATERIALS AND METHODS

The study was conducted from December 2018 to March 2020. It received ethical approval from Human Ethics and Research Committees of four tertiary health institutions in Lagos State, Nigeria. The participants were those who reported to the said tertiary health facilities within 6hours of the spinal cord injury and were profiled within 24hours of their arrival into the hospitals. Their socio-demographic characteristics (age, sex, marital status, educational level, and occupational status) and clinical variables (type, cause, level, duration and severity of injury, level of consciousness and knowledge of emergency response of rescuers, health seeking pathways post injury, time of surgery after arrival, reason for quick or delayed surgery, kind of vehicle and sitting position of patients involved in motor vehicular accidents) were obtained through structured interview, assessed immediately or later during the study period obtained directly from the patients or their proxies.

The American Spinal Injury Association (ASIA) Impairment Scale (American Spinal Cord Injury Association, 2002) was used to evaluate the severity of injury and classify the spinal cord injury (Kirshblum *et al*, 2011). The Spinal Cord Independence Measure was used to assess their functional performance (Catz and Itzkovich, 2007). The Walking Index for Spinal Cord Injury II (WISCI 2) was used to assess the walking function recovery (Ditunno *et al*, 2004). The Neuromuscular Recovery Scale was used to assess neuro-muscular recovery (NMR) (Harkema *et al*, 2018). Assessment was done at initial contact and at every 6 weeks over a 24-week period.

RESULTS

Twenty-nine (20 males) patients participated in the study and are as presented. Participants were aged between 15-58 years (Table 1) with a mean and mode age of 36.75±11.75 years and 31-45years respectively. Twenty of them were male (69.0%) while nine (31.0%) were female; male to female ratio was 2:1. Thirteen participants were single and never married (44.8%), 48.3% were married while 6.9% were widowed. More than a third (34.5%) of the participants had secondary level of education while 20.7% completed primary education (table 1). The participants were in diverse array fields of occupation (Table 1). Nineteen (65.5%) participants sustained injuries through road crash, 20.6% from falls or diving into a shallow pool (Table 1).

Sixteen (55.2%) of the participants lost consciousness immediately post TSCI impact while thirteen (44.8%) remained conscious (Table 1). Of those injured through road crash, 5.3% was drunk driver at night without headlamps; 31.6% were hit and run victims while 63.1% were passengers of commercially driven vehicles. Eighteen (62.1%) had cervical spine injuries, 10.2% had thoracic spine involvements while 27.5% had lumbar spine injuries (Table 2). Using the American Spinal Injury Association (ASIA) Impairment Scale, 31.0% were in ASIA A classification, 24.2% in ASIA B, 31.0% in ASIA C while 13.8% were ASIA D (Table 2).

Majority (87.5%) of the unconscious patients had cervical spine injuries while those that remained conscious were mostly lumbar spine injured (24.14%) (Fig.1). Of those who were unconscious, 37.5% were in ASIA-A classification, 12.5% were ASIA-B, 31.25% were ASIA-C while and 18.75% were ASIA-D. Three of the patients that remained conscious at the time of impact were ASIA-A, 6 were ASIA-B, 3 were ASIA-C while was one was ASIA-D. Eighteen (62.1%) of the participants had surgical interventions while 37.9% were managed conservatively (Fig. 2). Of the patients that had surgery, five (17.1%) had surgery 2-10 days post TSCI.

Table 1:
Socio-demographic and Clinical Profile of the Participants.

	Variables	Number	%
Age Range	≤ 15	1	3.4
	16-30	9	31.0
	31-45	13	44.8
	46-60	6	20.7
Marital Status	Single Never Married	13	44.8
	Married	14	48.3
	Widowed	2	6.9
Highest Education Attained	Primary Education	6	20.7
	Secondary Education	10	34.5
	Tertiary Education	9	31.0
	Postgraduate	4	13.8
Occupation	Student	1	3.4
	Professionals	9	31.0
	Clerical Support Workers	1	3.4
	Service and Sales Workers	10	34.5
	Crafts and related trades	7	24.1
	Armed Forces	1	3.4
Cause of Injury	Motor vehicular Crash	19	65.5
	Trado-medical accident	1	3.4
	Falls from Height/Dive to pool	6	20.6
	Work site/Industrial accidents	3	10.3
Spinal Level of Injury	Cervical (C4/C5 and C6/C7)	18	62.1
	Thoracic (T4, T9 and T11/T12)	3	10.3
	Lumbar (L1/L2 and L3/L4)	8	27.6
Severity of Injury	ASIA A	9	31.0
	ASIA B	7	24.2
	ASIA C	9	31.0
	ASIA D	4	13.8
Level of consciousness	Conscious	44.8	13
	Unconscious	55.2	16

Key: **ASIA-A**: Complete spinal cord injury with no preserved sensory/motor function below neurological level. ***ASIA-B**: Incomplete Spinal cord injury with preserved sensory but no motor function below neurological level and include sacral segments S4 and S5.*
***ASIA-C**: Incomplete Spinal Cord Injury with preserved sensory and motor function in which more than half of key muscles below neurological level have a muscle grade less than 3.*
***ASIA-D:** Incomplete Spinal Cord Injury with preserved sensory and motor function in which at least half of the key muscles below the neurological level have a muscle grade 3 or more.*

The other patients' surgical intervention was delayed mostly due to financial constraints. All the participants had delayed surgical intervention with some being delayed as much as two months post-injury (Fig. 2). The initial health seeking pathways of patients' post-TSCI is described in Fig. 3. Twenty-five patients (86.2%) were taken to state-owned emergency trauma/accident and emergency Centre while 13.8% were carried to private hospitals for emergency care before being referred to any of the four tertiary hospitals. A patient discontinued participation after five weeks in the study to seek traditional intervention.

At baseline, 6.9% of participants had severe upper extremity impairment while 48.3% of them had normal upper extremity function (Table 2). At 12-Week, 5.3% had severe upper extremity impairment while 63.2% of them had normal upper extremity function (Table 2). However, at 24-Week, no participant had severe upper extremity impairment and 50% of them had attained normal upper extremity function (Table 2).

At ictus, 13.8% of participants had severely altered pin prick sensation while 51.7% of them had normal sensation (Table 2). At 12-week, 63.2% participants had normal pin prick sensation. However, at 24-Week, 16.7% of participants had severe pin prick sensation impairment, while 58.3% of them had attained pin prick sensation (Table 2).

Table 2:
Pattern of Distribution of Severity of Injury in Participants

	Variables	Baseline (n%)	Week 12 (n%)	Week 24 (n%)
Upper Extremity Motor Scores	Paralysed	2(6.90)	1(5.30)	0(00.0)
	Severe	5(17.2)	2(10.5)	2(16.7)
	Moderate	8(27.6)	3(15.8)	3(25.0)
	Mild	0(00.0)	1(5.20)	1(8.30)
	Normal	14(48.3)	12(63.2)	6(50.0)
Lower Extremity Motor	Paralysed	18(62.1)	12(63.2)	6(50.0)
	Severe	5(17.2)	1(5.20)	2(16.7)
	Moderate	1(3.50)	2(10.5)	1(8.30)
	Mild	3(10.3)	1(5.20)	0(00.0)
	Normal	2(6.90)	3(15.8)	3(25.0)
Light Touch	No sensation	2(6.90)	0(00.0)	0(00.0)
	Severely Altered	4(13.8)	2(10.5)	2(16.7)
	Moderately Altered	2(6.90)	1(5.30)	0(00.0)
	Mildly Altered	9(31.0)	5(26.3)	2(16.6)
	Normal	12(41.4)	11(57.9)	8(66.7)
Pin Prick	No sensation	0(00.0)	0(00.0)	0(00.0)
	Severely Altered	4(13.8)	0(00.0)	2(16.7)
	Moderately Altered	3(7.60)	3(15.8)	0(00.0)
	Mildly Altered	7(24.2)	4(21.0)	3(25.0)
	Normal	15(51.7)	12(63.2)	7(58.3)

Figure 3 shows the graphical representation of the Pattern of the Neurological Recovery of participants with remarkable improvement from the initial assessment through the 24-Week of the interventions. At Baseline, 31.03% of the participants had no preserved sensory or motor function below the neurological level (ASIA-A) 24.14% had only sensory function preserved below the neurological level, including the sacral segments S4–S5 (ASIA-B), 31.03% had preserved motor function in which more than half of key muscles below the neurological level had a muscle grade less than oxford muscle grade 3 (ASIA-C) while 13.79% had preserved motor function in which at least half of the key muscles below the neurological level had a muscle grade on oxford muscle grade of 3 or more (ASIA-D) (Fig. 4). At 12-Week, 17.24% of the participants were in ASIA-A, 20.69% were ASIA-B, 17.24% were ASIA-C, 6.70% were ASIA D while 3.45% was ASIA-E with all muscle and sensory perceptions intact (Fig. 4).

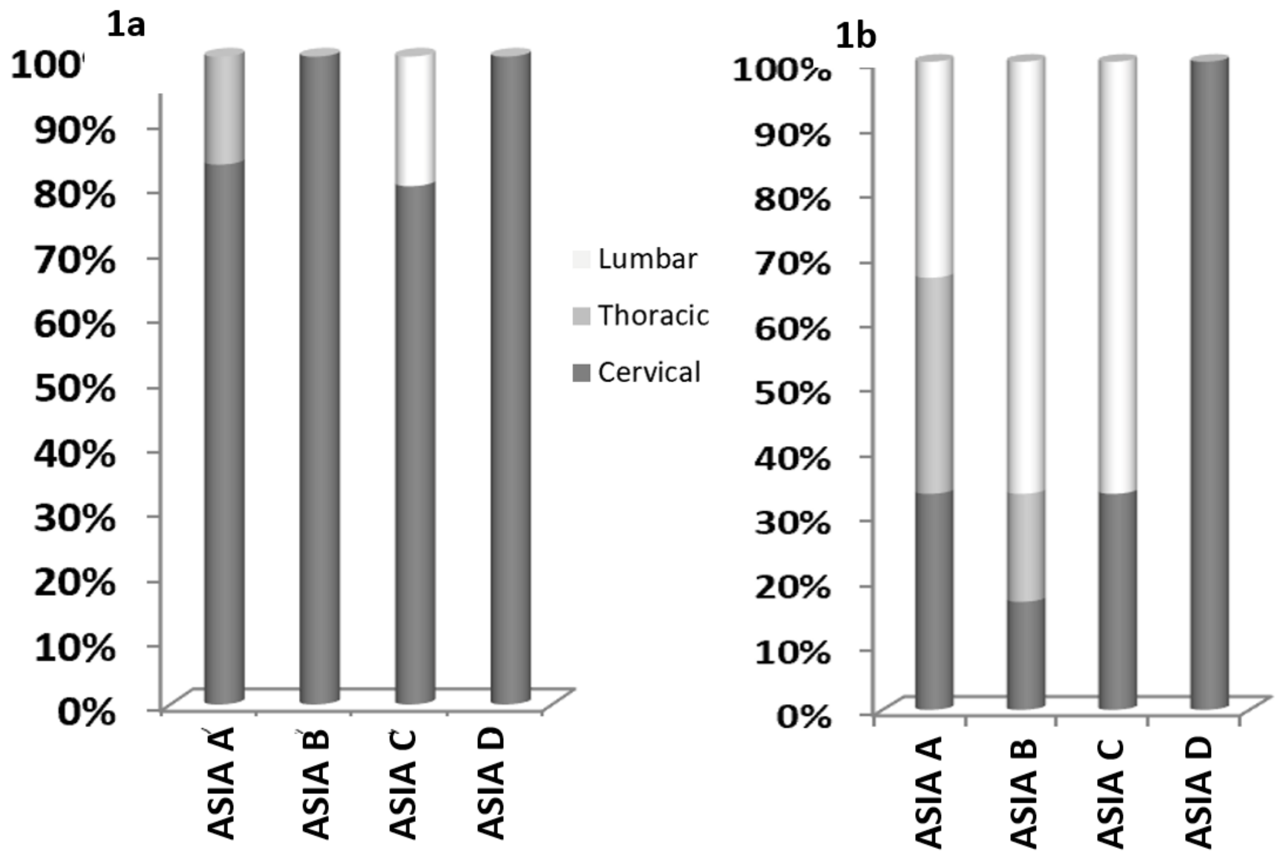

Figure 1:
Severity of Injury of the Unconscious (1a) and Conscious (1b) Patients
1a - A set of four calibrated column charts denoting cervical, thoracic and lumbar vertebral level of injury and injury severity in patients who became unconscious at point of Traumatic Spinal Cord Injury impact. Most of them had Cervical vertebra level of injury.
1b- A set of four calibrated column charts denoting cervical, thoracic and lumbar vertebral level of injury and injury severity in patients who remained conscious at point of Traumatic Spinal Cord Injury impact. Most of them had Lumbar vertebra level of injury

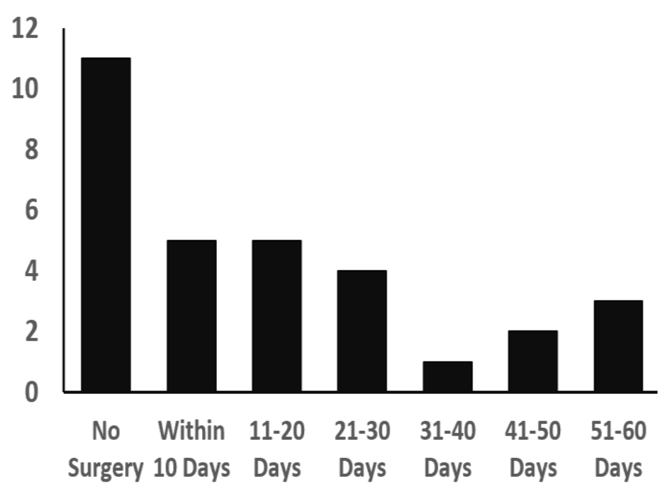

Figure 2:
Time of Surgery Post-Traumatic Spinal Cord Injury. Colum represents data of patients that opted for conservative management of spinal fracture sites after Traumatic Spinal Cord Injury and those that had decompression and/or stabilization surgery and when it was done after injury.

At 24-Week10.35% were each on ASIA-A, and ASIA-B, 6.70% each on ASIA-C, ASIA-D ASIA-E respectively (Fig. 4).

The level of Independent Functional Performance of the participants also improved dramatically from first assessment to the end of the 24 weeks of treatments (Table 3) At Baseline in the Self Care domain of the SCIM, 65.5% participants were fully dependent while only 6.9% participants were independent which improved to 18.2% being independent at 24-week. A few (10.3%) of the participants were dependent on respiratory support at baseline, while 17.8% were independent while at 24-week, 63.6% of participants were independent. Majority (86.2%) of the participants were fully dependent in mobility with none being dependent at the initial assessment. However, at 24-week, only 27.2% of the participants were fully dependent while 36.4% could walk, with or without support (Table 3). On the overall functional performance 21 out of the 29 participants were fully dependent at initial contact while only 2 of them were fully dependent at 24-week (Fig. 4).

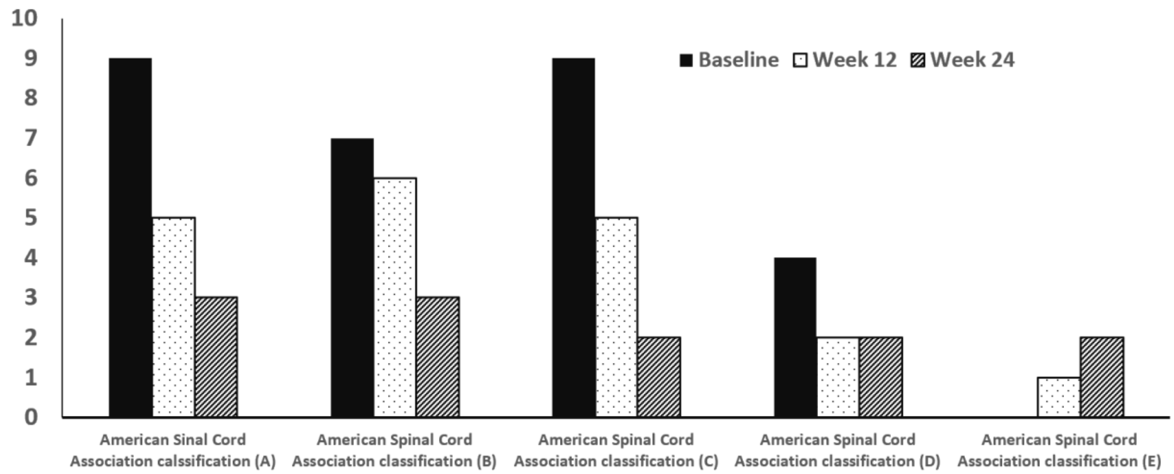

Figure 3
Pattern of the Neurological Recovery of patients after Traumatic Spinal Cord Injury from point of first contact to 6 months after treatment and relating these to injury severity. Significant Neurological Recovery was recorded after 3 to 6 months of physiotherapy treatment.

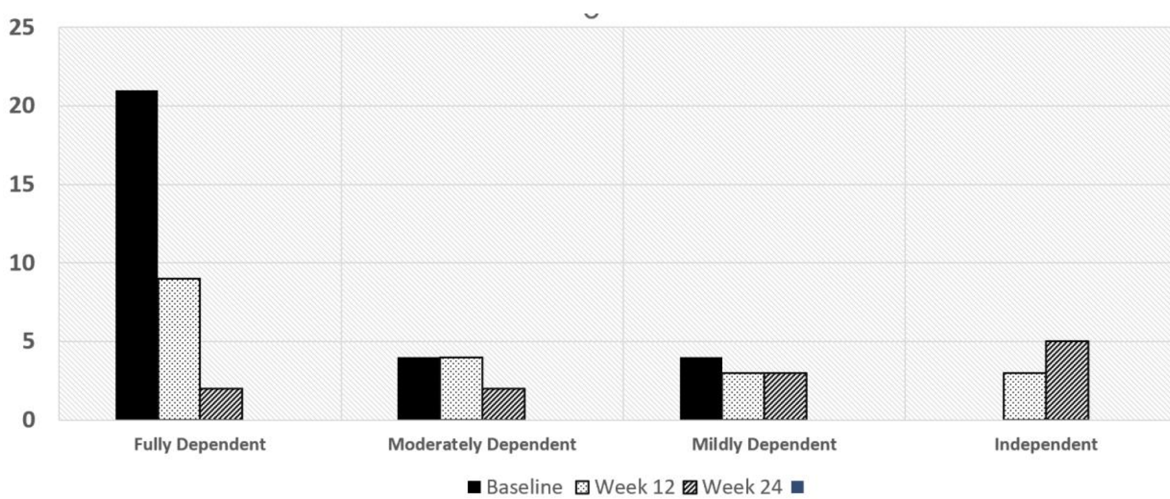

Figure 4
Overall Independent Functional Performance of the Participants from first contact to 6 months of treatment. Patients graduated from fully dependent to moderately and mildly dependent and some became fully independent.

Table 3:
Pattern of Independent Functional Performance Recovery of the Participants

		Baseline n (%)	Week 12 n (%)	Week 24 n (%)
Selfcare	Fully Dependent	19(65.5)	7(36.8)	2(18.2)
	Moderately Dependent	5(17.3)	4(21.1)	2(18.2)
	Mildly Dependent	3(10.3)	3(15.8)	1(9.10)
	Independent	2(6.9)	5(26.3)	7(54.5)
Respiration and Sphincter Management (RSM)	Fully Dependent	3(10.3)	1(5.30)	0(00.0)
	Moderately Dependent	21(72.5)	9(47.3)	2(18.2)
	Mildly Dependent	0(00.0)	5(26.3)	2(18.2)
	Independent	5(17.8)	4(21.1)	8(63.6)
MOBILITY	Fully Dependent	25(86.2)	12(63.2)	3(27.2)
	Moderately Dependent	3(10.4)	3(15.7)	4(36.3)
	Mildly Dependent	1(4.40)	1(5.30)	0(00.0)
	Independent	0(00.0)	3(15.8)	5(36.4)

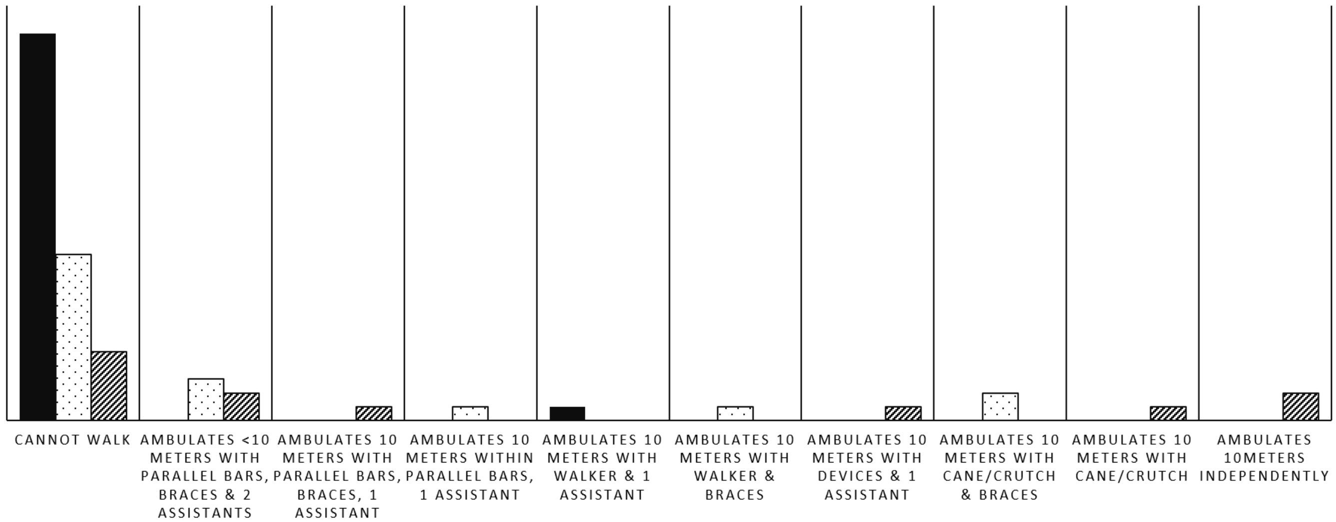

Figure 5:
Phases and stages of walking function recovery of study participants. It shows progress from being unable to walk at first point of contact to walking 10 meters with or without support following 6 months of treatment.

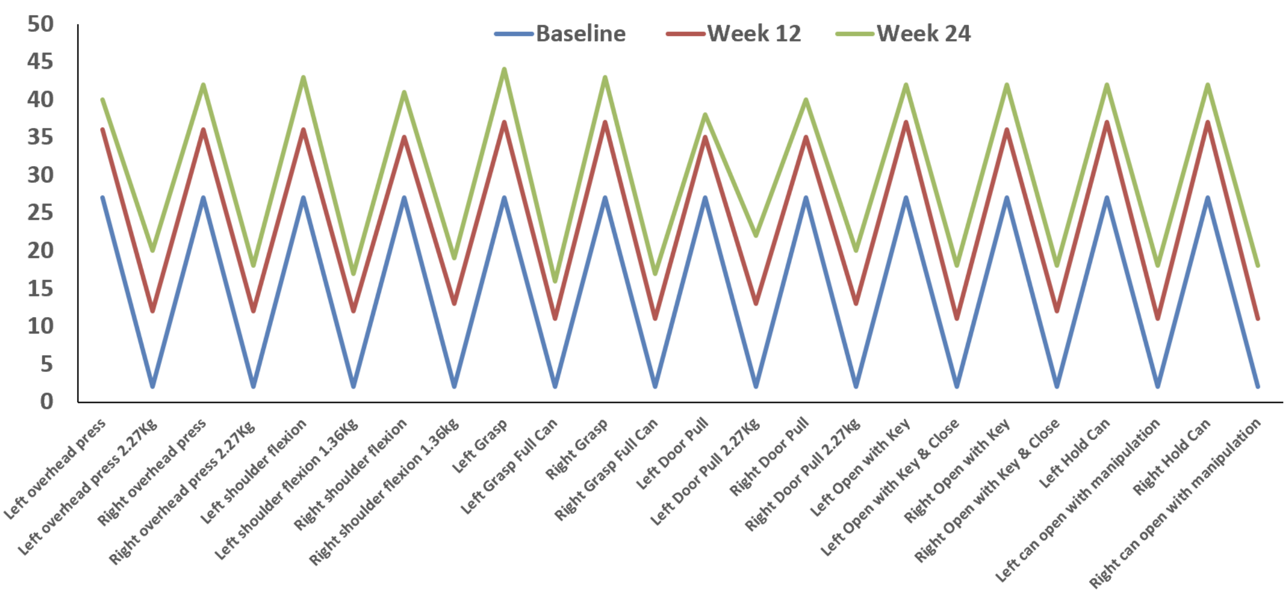

Figure 6
Neuromuscular Recovery in the Left and Right Upper limbs of participants after acute Traumatic Spinal Cord Injury following 6 months of physiotherapy treatment. It shows significant improvement except in the Left and Right Open with Key domain

The walking performance of the participants showed remarkable improvement from baseline through the 24 weeks of interventions (Table 3 and Fig. 5). At Baseline, 96.6% of participants were unable to stand and/or participate in assisted walking, at 12-week, 15.7% were able to ambulate within parallel bars for less than 10 meters, with support from braces and two assistants and 10.6% could ambulate for 10 meters, with one cane/crutch and braces while at 24-week, 8.30% of the participants could ambulate with one cane/crutch for 10 meters and 16.7% of them could ambulate independently for 10 meters. All the upper limb functions showed clinically significant recovery throughout the treatment periods (Fig. 6).

Pattern of Neuromuscular Recovery of the Trunk and Lower Limb Functions of the participants is graphically represented in Fig. 7. In the Sit domain of the NRS at baseline, 100.0% participants were unable to attain and hold appropriate head, shoulder and trunk posture and pelvis positioning and maintain indefinitely. The same held true at 12-Week. At 24-Week, 50.0% participants were able to attain and hold appropriate head, shoulder and trunk posture and pelvis positioning and maintain indefinitely while the other half (50.0%) could attain and maintain balanced sitting indefinitely. The Reverse Sit Up domain showed that all the participants were unable to slowly lower the trunk unto the mat in a controlled manner using elevated arms to provide a counterbalance and/or knee extension and/or significant hip flexion.

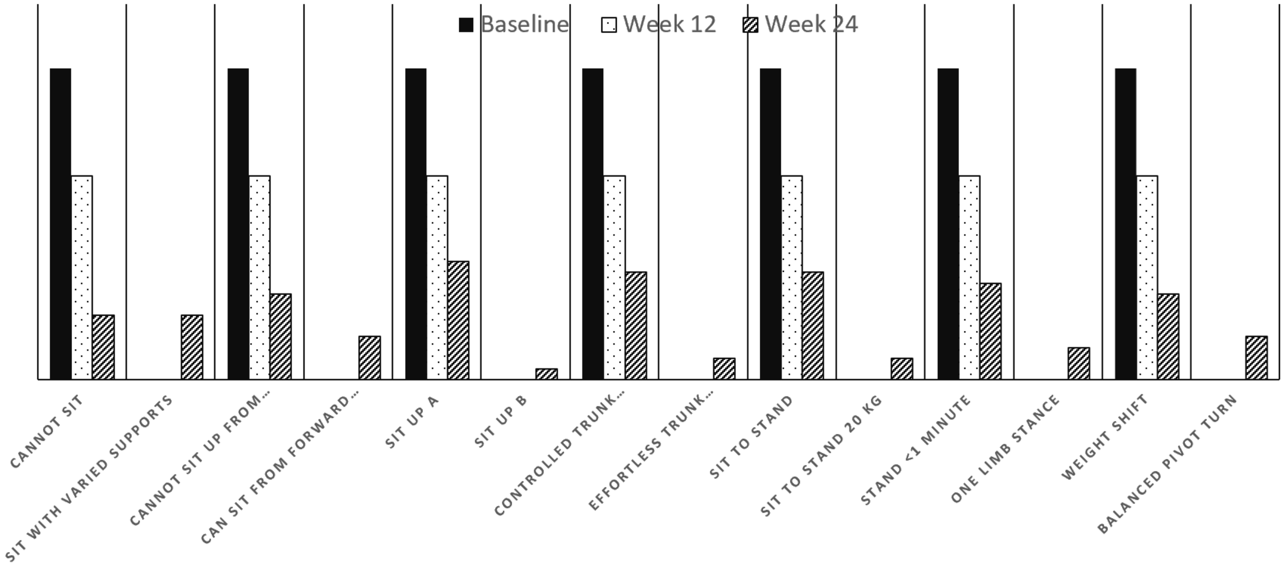

Figure 7
Neuromuscular Recovery in the Trunk and Lower limbs of participants after acute Traumatic Spinal Cord Injury following 6 months of physiotherapy treatment. It shows significant improvement except in the Sit to stand domain.

Table 4:
Comparison of Functional Performance, Walking Function and Neuromuscular Recovery over the 24-Week Period.

	Variables	Body Side	Mean rank for					Friedman Value	df	p-Value
			Week 0	Week 6	Week 12	Week 18	Week 24			
Upper Limb Neuromuscular Recovery	Overhead Press	Left	1.00	2.00	3.33	4.17	4.50	11.418	4	0.022*
		Right	1.00	2.00	3.33	4.17	4.50	11.418	4	0.022*
	Shoulder Flexion	Right	1,00	2.00	3.50	4.00	4.50	11.333	4	0.023*
	Grasp	Left	1.00	2.00	3.00	3.50	4.00	10.154	4	0.038*
		Right	1.00	2.00	3.00	3.50	4.00	10.154	4	0.038*
	Door Pull	Right	1.00	2.00	3.80	3.80	4.33	11.529	4	0.021*
	Open with Key	Left	1.50	3.17	3.17	3.17	4.00	8.00	4	0.092
		Right	1.50	3.17	3.17	3.17	4.00	8.00	4	0.092
	Can Open Manipulation	Left	1.00	3.50	3.50	3.50	3.50	12.00	4	0.017*
		Right	1.00	3.50	3.50	3.50	3.50	12.00	4	0.017*
Lower Limb Neuromuscular Recovery	Sit	--	1.10	1.90	3.40	4.00	4.60	18.769	4	0.001*
	Reverse Sit up	--	1.00	2.70	2.83	4.00	5.00	11.864	4	0.018*
	Sit up	--	1.00	2.70	2.83	4.00	5.00	11.864	4	0.018*
	Trunk Extension in Sitting	--	1.50	1.50	3.00	4.00	5.00	12.000	4	0.017*
	Sit to Stand	--	1.33	2.00	3.38	4.17	3.67	8.863	4	0.065
	Stand	--	1.17	1.83	3.33	4.17	4.50	11.259	4	0.024*
	Walking	--	1.50	1.83	2.67	4.50	4.50	11.385	4	0.023*
Walking Functional Recovery	Walking Index Score	--	2.25	2.25	3.25	3.50	3.75	5.538	4	0.236
Functional Performance Recovery	Self-care	--	1.63	2.13	3.25	3.63	4.38	11.429	4	0.022*
	Respiration & Sphincter Management	--	1.63	2.13	3.00	3.88	4.38	11.724	4	0.020*
	Mobility	--	1.25	2.25	3.25	3.50	4.50	11.862	4	0.018*

**p<0.0.05*

Same held true at Week 12. At 24th Week, 66.7% participants could initiate Reverse Sit Up while 33.3% attained full Reverse Sit Up by slowly lowering their trunk halfway toward the mat in a controlled manner without significant effort, then rotating the trunk left and right and returning to sitting without resting on the mat and with arms across the chest. At Baseline and at 12th Week, all the participants were unable to raise head, shoulders, and trunk off the mat and assume a sitting position by using elevated arms to provide a counterbalance and/or knee extension and/or significant hip flexion (initiate Sit Up). At 24th Week, 91.7% participants could initiate Sit Up while the rest (8.3%) could initiate Sit Up as well as assume a sitting position with arms across chest and without significant effort. At Baseline and at 12th Week, all the participants were unable to able to return to sitting from a forward flexed position and with arms hanging down, while maintaining thoracic and lumbar spine extension with significant effort (Controlled Trunk Extension in Sitting). At 24th Week, 83.3% participants could perform controlled TEIS while 16.7% with hands behind head could lower trunk to knees and return to sitting while maintaining lumbar and thoracic spine extension in a controlled manner without significant effort.

At baseline and at 12th Week, 100.0% participants were unable to steadily raise self into an upright position with appropriate kinematics of the head, shoulders, trunk, pelvis, knees, and ankles and without using arms as a counterbalance, from sitting on the edge of the mat with the feet on the floor (initiate Sit to Stand). At 24th Week, 83.3% participants could initiate Sit to Stand while 16.7% could progress to Stand while sitting on the edge of a chair with feet on floor and hips at 100 degrees of flexion, with appropriate kinematics, without significant effort and without using arms as counterbalance (Fig. 7). At Baseline and at 12th Week, all the participants were unable to maintain standing with proper trunk posture and position of pelvis and legs using arms for a counterbalance for less than 1 minute (Maintain Stand). At 24-Week, 75.0% participants were able to Maintain Stand while 25.0% were able to achieve and maintain single limb stance (both legs) for 30 seconds after achieving tandem stance position for 30 seconds (Fig. 7). At Baseline and at 12th Week, all the participants were not able to shift weight from side to side (Weight Shift). At 24th Week, 66.7% had attained Weight Shift while 33.3% were able to descend an incline maintaining normal over ground walking speed and to complete a pivot turn without hesitation while maintaining balance (Balanced Pivot Turn) (Fig. 7).

In assessing the Functional Performance, Walking Function and Neuromuscular Recovery from acute stage through the 24 weeks, there was steady clinical improvement of Functional Performance from baseline through 24 weeks, with significant (p=0.0001) improvements across the five points of measurement and in all three domains of the functional independent performances. Although walking function improved clinically, it was not statistically different from baseline through week 24. There was also significant (p=0.0001) Upper Limb Neuromuscular Recovery, Trunk and Lower Limb Neuromuscular Recovery of participants from Baseline to week 24 (Table 4).

DISCUSSION

This study documented socio-demographic and clinical profiles of individuals with traumatic spinal cord injury in Lagos state Nigeria who accessed healthcare services immediately after their spinal cord injury and presents the pattern of their neuro-motor recovery, functional performance and regaining and returning of walking function over a two-year period. This study is important as it has not only contributed to the pool of data on the socio-demographic and clinical profiles of individuals with spinal cord injury at the acute phase of the injury especially from low-and-middle income countries, it has improved the knowledge on the pattern of neuro-motor and functional recovery in these individuals and empirically shows how this can be expedited for independent functioning in order to improve productivity and reduce burden of care on the informal caregivers.

Spinal cord injury and the associated disability have been of great burden both to the healthcare system globally and to the economic sustainability of a family and the society alike. Although traumatic spine injuries have diverse causes and occur at different levels with varying severity, there is still no known cure for a severely damaged spinal cord. Hence, the age range of the participants in this study is of both clinical and economic importance. It shows that traumatic spinal cord injury is most common among the productive age group. This has a far-reaching economic consequence for national development. Hence, efforts targeted at reducing the menace will improve the productivity of the countries. The age of participants in this study ranged between 15 and 58 years, with 10 (34.5%) of them between the 15-30 years age range and 19 (65.5%) between the 31-60 years age range. Lenehan *et al*, (2012) reported a bimodal age profile distribution of individuals with a TSCI, with one peak between 15 and 29 years of age and the second, smaller but growing peak in those >50 years of age.

The fact that road traffic crash contributes to more than 50% of the cases may be predicated on two assumptions of either over-speeding or bad roads or both. Although the issue of bad roads is not surprising as most roads in Nigeria are in bad shape, not motor able and dangerous to driving. This is complemented by the fact that most of the participants in this study are passengers in commercial buses/cars. This study showed that the majority of the TSCI patients were young and work-age male adults, implying a vacuum and negative impact on the socioeconomic strength in their respective spheres of influence. This finding is similar to those reported in previous studies in Nigeria (Solagberu 2002; Udosen *et al*, 2007; Obalum *et al*, 2009) and other developing countries (Rahimi-Movaghar *et al*, 2013; Kang *et al*, 2018). However, according to Ahuja *et al* (2017) there is an emerging demographic shift in SCI towards an older population of individuals because of the aging population of the world (Chen *et al*, 2016). In this study, for every two males with TSCI, one female was injured. Other studies found a 4:1 male/ female ratio (Chen *et al*, 2016; Ahuja *et al*, 2017; Udoh and Obeta, 2019) and the difference might be attributed to the sample size of this study. Married patients with TSCI were more than the patients who were single and never married. Joseph *et al* (2015) reported that a larger population of younger and single individuals are involved in TSCI in more advanced countries and attributes this to the faster pace of life in those climes. High-energy impact episodes such as traffic accidents and sport-related injuries, are more common in younger individuals, whereas TSCI from low-energy impacts, such as falls, disproportionately occur in individuals >60 years of age (DeVivo and Chen, 2011). The highest rate of injury associated with level of educational attainment in this study was among patients with secondary school level education, as corroborated by studies from other climes (Joseph *et al*, 2015). The likelihood of employment after injury is greater in patients who are younger, male, and white and who have more formal education, higher reported intelligence quotient (IQ), greater functional capacity, and with spinal cord injury classified as American Spinal Injury Association (ASIA) level D (American Spinal Injury Association, 2002; Joseph *et al*, 2015). The highest population of occupations among patients in this study were service and sales workers, professionals in various fields of endeavour as well as the crafts and related trades. The former and the latter occupations are composed of self employed individuals who are likely to be able to return to work within a year of TSCI but professionals are less likely to be accepted back to their pre-injury employment status as employment rates after TSCI generally remain low (Schonherr *et al*, 2004; Chen *et al*, 2016).

Studies conducted in Nigeria, (Solagberu, 2002; Obalum *et al*, 2009; Udoh and Obeta 2019) reported motor vehicular accidents (MVA) as the highest cause of TSCI, closely followed by falls. Most (n= 19) of the participants in this study were involved in MVAs and were passengers of commercial vehicles. Banita *et al*, (2021) reported a similarity of this occurrence in India, which is similar to Nigeria in that it is a third world country. However, researchers (Rahimi-Movaghar *et al*, 2009; Joseph *et al*, 2015) reported assault such as gunshots, stabbing and blunt trauma to be the most common cause of TSCI in South Africa and falls appear to be more common in developed countries (Rahimi-Movaghar *et al*, 2009; Nijendijk *et al*, 2014; Chin *et al*, 2018). Our findings that MVAs are the most frequent cause of TSCI may be due to drunken driving, over speeding, ineffective enforcement of traffic safety regulations, and dilapidated roads in Lagos State and Nigeria in general (Nasidi *et al*, 2019). This study reports cervical TSCI as the most common level of injury and closely related to loss of consciousness at the point of TSCI impact (Chen *et al*, 2016). The higher numbers of cervical injuries presuppose a higher number of patients with tetraplegia but van derWesthuisen *et al*, (2017) reports a higher (65%) number of paraplegic TSCI from a South African study. With respect to the severity of injury in the present study, patients who suffered complete impairment (ASIA-A) have the highest incidence of loss of consciousness than the patients with ASIA-B, C and D, which is consistent with the findings reported in other studies (Rahimi-Movaghar *et al*, 2013; Montoto-Marqués *et al*, 2017).

Eighteen (62.1%) of the 29 patients in this study had early surgical decompression or stabilisation post-TSCI. The time of surgery post injury ranged from 2 days to 58 days and the disparity in time is attributed to financial constraints among most patients. Although studies support the surgical decompression within 24 hours in complete SCI to optimize neurological recovery especially in patients with cervical SCI (Bourassa-Moreau *et al*, 2016; van derWesthuisen *et al*, 2017), this current Nigeria-based study has found no evidence to show that the surgically managed patients fared better than the patients that had early conservative treatment of the injured spine (Bourassa-Moreau *et al*, 2016; Harvey, 2016; Udoh and Obeta, 2019).

The initial health seeking pathways reported by participants in this study was determined by their rescuers as the first responders, especially for MVA patients. They were conveyed in non-specialized vehicles (e.g. saloon cars or public buses) for emergency care, by rescuers without any formal training on patient handling techniques post-TSCI, and might have unintentionally worsened the patients' prognosis (Ahuja *et al*, 2017; Chin 2018). Gemperli *et al*, (2017), reported that an instance in which care was required but was not received was rare in Switzerland and more likely in participants with migration background, implying that wealthier countries have better citizen-centred healthcare than developing countries. No patient (or their proxy) in this study reported being conveyed to hospital in an ambulance post initial TSCI, implying that any advanced trauma life support eventually received was delayed.

It is vital that people with TSCI live a physically active lifestyle to promote long-term health and well-being. Early Physiotherapy treatment started at the acute phase of TSCI provided this for participants in this study as it resulted in clinical and statistically significant improvements in Functional Performance, Walking Function and Neuromuscular Recovery in these patients, after 24 weeks of treatment with Transcutaneous Interrupted Direct Current and Conventional physiotherapy.

Functional Performance was clinically and significantly improved in the Self care, Respiratory and Sphincter Management and the Mobility domains of the SCIM. Kapadia *et al*, (2014) reported an improvement in the mobility domain of the SCIM, 16 weeks post Functional Electrical Stimulation and Body Weight Support Threadmill and Harness System (BWSTS) in chronic incomplete TSCI. It is worth pointing out that their study participants were in chronic stage TSCI and only one domain of the SCIM improved. By implication, the present study has shown that adequate rehabilitation management when delivered early can restore independent functioning, thereby reducing the burden of care on the family and informal caregivers of patients post TSCI.

There was a stepwise and steady pattern of improvement in the walking function recovery of participants, though the improvement was not statistically significant. This result is corroborated by Dobkin *et al*, (2007) who concluded that time after SCI is an important variable for entering patients into a trial with mobility outcomes. A two-year study by Fox *et al*, (2010), also showed the possibility of walking function recovery without statistical significance.

The improvement in Neuromuscular Recovery was evident in all domains of the NRS except in the Left and Right Open with Key and the Sit to stand domains of the scale. Inanici *et al* (2018) found improved long term recovery of upper extremity function, in chronic tetraplegia following Physiotherapy treatment. Similar improvements in trunk and lower limb control were reported in studies by Rejc *et al*, (2015; 2017) and Angeli *et al*, (2018), who involved patients with chronic SCI treated with epidural stimulation in their studies,

This study is limited by the small sample size with distribution skewed towards the male gender, which might not allow extrapolation of the findings. The sample size could not be helped however as the data collection had to be terminated due to its clash with the corona virus induced lockdown in March 2020. Furthermore, our patients were recruited from all tertiary hospitals in Lagos State and this number met the inclusion criteria. It is recommended that future studies should consider recruiting a larger sample size to be treated with appropriate for a longer study period, and include patients admitted in private hospitals.

In conclusion, traumatic spinal cord injury is common in males of productive age and affects more cervical spine resulting in quadriplegia/quadriparesis. Individual with spinal cord injury had steady significant neuromotor and functional recovery over 6-month after injury.

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