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ORIGINAL ARTICLE

Pattern of spinal cord Injury in young adults: Etiology, level of injury and associated complications.

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ABSTRACT… Objective: To determine pattern of spinal cord injury in young adults aged 18–35 years, identify etiologies, most common neurological levels and types of early medical complications. **Study Design:** Cross Sectional Analytical study. **Period:** January 2024 to June 2025. **Setting:** Allama Iqbal Teaching Hospital, DG Khan Medical College, Dera Ghazi Khan. **Methods:** Three hundred sixty two young adults with imaging-confirmed traumatic spinal cord injury were enrolled consecutively. Demographics, mechanism of injury, ASIA impairment grade, anatomical level, time to presentation, and complications within three months were documented on a structured proforma. Chi-square tests and logistic regression were performed in SPSS version 21.0 to identify predictors of early complications. **Results:** Males constituted 85.1% of participants (mean age 26.7 ± 5.4 years). Road traffic accidents caused 62.2% of injuries, followed by falls (27.1%), sports injuries (6.6%), and violence (4.1%). Cervical injuries predominated (52.2%), and 63.8% were complete (ASIA A). Complications developed in 67.9%, led by urinary tract infections (29.8%), pressure ulcers (26.0%), neurogenic shock (21.0%), and respiratory failure (18.8%). Cervical level strongly predicted respiratory failure (OR 6.2; 95% CI 3.8–10.1), and complete lesions were linked to pressure ulcers (OR 3.1; 95% CI 2.0–4.8). **Conclusion:** Traumatic spinal cord injury in young adults of southern Punjab is predominantly caused by road traffic accidents; most frequently involves the cervical spine, and carries a high early complication burden, underscoring the need for targeted prevention strategies and multidisciplinary rehabilitation.

Key words: Accidents, Spinal Cord Injuries, Traffic, Tetraplegia, Young Adult.

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INTRODUCTION

Spinal cord injury (SCI) is a devastating neurological condition resulting from damage to the spinal cord, leading to temporary or permanent alterations in its motor, sensory, or autonomic functions.[1] Globally, the incidence of traumatic SCI ranges from 40 to 80 cases per million population annually, with over 250,000 to 500,000 new cases occurring each year.[2] The World Health Organization (WHO) recognizes SCI as a major public health concern due to its profound impact on individuals, families, and healthcare systems, particularly in low- and middle-income countries (LMICs) where resources for acute management and long-term rehabilitation are limited.[3]

Young adults aged 18 to 35 years represent a disproportionately affected demographic in the epidemiology of SCI. This age group is not only more likely to engage in high-risk behaviors but also faces the greatest burden of long-term disability, as SCI often occurs during peak productive and reproductive years.[4] In many regions, up to 60% of SCI cases occur in individuals under the age of 35, with males being affected 2–4 times more frequently than females.[5] The long life expectancy following injury amplifies the personal, social, and economic consequences, including loss of employment, increased dependency, and substantial lifetime healthcare costs.[6] For example, a 2022 study in the United States estimated that the average lifetime cost for a young adult (aged 25) with high tetraplegia exceeds $5 million, underscoring the economic gravity of early-onset SCI.[7]

The primary causes of SCI in young adults are largely traumatic and closely linked to lifestyle and environmental factors. Road traffic accidents (RTAs) remain the leading cause globally, particularly in LMICs, where rapid urbanization and inadequate road

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safety infrastructure contribute to high injury rates.[8] Other significant etiologies include falls (especially from heights), sports related injuries (e.g., diving, contact sports), and acts of violence (e.g., gunshot or stab wounds).[9] The vulnerability of young adults stems from a combination of physiological maturity, risk-taking behaviors, and greater exposure to hazardous environments factors that heighten their likelihood of sustaining traumatic injuries.[10]

Despite advances in trauma care and rehabilitation, individuals with SCI frequently experience a range of early complications that significantly affect recovery and quality of life. These include neurogenic shock, respiratory insufficiency (particularly in cervical injuries), deep vein thrombosis (DVT), pressure ulcers, urinary tract infections (UTIs), and psychological disorders such as depression and anxiety.[11] These complications not only prolong hospitalization but also increase morbidity and mortality in the acute phase.[12]

The findings of this study will inform targeted prevention programs, enhance early clinical management, and support the development of specialized rehabilitation services tailored to young adults. By identifying modifiable risk factors and common complications, this research contributes to reducing the global burden of SCI and improving long-term outcomes in a vulnerable and socially impactful population.

OBJECTIVE

To determine pattern of spinal cord injury in young adults aged 18–35 years, identify etiologies, most common neurological levels and types of early medical complications.

METHODS

This cross sectional analytical study was conducted at Allama Iqbal Teaching Hospital, DG Khan Medical College, Dera Ghazi Khan from January 2024 to June 2025. Ethical approval was obtained from the Institutional Review Board (IRB) of DG Khan Medical College prior to data collection (Reference No. /051/314/MED/DGKMC, Dated: 8-8-2024). Patient confidentiality was maintained through anonymization of data and written informed consent was obtained from all participants or their legal guardians. The sample size was calculated using the WHO sample size calculator for cross sectional studies, based on an estimated prevalence of 62%[13] for road traffic accidents (RTAs) as the leading cause of SCI in individuals aged 18–35 years, 95% confidence level and 5% margin of error. This yielded a minimum required sample size of 362 participants. The study population comprised young adults aged 18 to 35 years diagnosed with acute traumatic spinal cord injury confirmed by clinical evaluation and imaging (MRI/CT). Inclusion criteria were: age between 18–35 years and confirmed traumatic SCI. Patients with non-traumatic SCI (e.g., due to tumors, infections, or vascular causes), incomplete medical records or those outside the specified age range were excluded. Data were collected using a structured, proforma designed to capture relevant variables, including demographic characteristics (age, sex, occupation), etiology of injury (categorized as motor vehicle accidents, falls, sports-related injuries, interpersonal violence, or others), level and completeness of spinal injury classified according to the American Spinal Injury Association (ASIA) Impairment Scale, and anatomical level (cervical, thoracic, lumbar). Additional variables included time from injury to hospital presentation, presence of associated injuries (such as fractures or traumatic brain injury), and complications occurring within the first three months post-injury. Complications were classified into medical (e.g., neurogenic shock, respiratory failure, deep vein thrombosis [DVT], urinary tract infections [UTI], pressure ulcers) and surgical (requirement for spinal stabilization surgery). Operational definitions were standardized: tetraplegia was defined as impairment of motor and/or sensory function in the cervical segments of the spinal cord affecting all four limbs, while paraplegia referred to involvement of thoracic, lumbar, or sacral segments with lower limb involvement. Complications were identified based on established clinical diagnostic criteria by attending physicians. Data were entered and analyzed using SPSS version 21.0. Descriptive statistics were used to summarize demographic and clinical characteristics, with categorical variables presented as frequencies and percentages, and continuous variables expressed as means and standard deviations. Inferential analyses included chi-square tests for categorical associations and independent samples t-tests

for group comparisons. Logistic regression was employed to explore potential predictors of early complications. All statistical tests were conducted at 5% level of significance.

RESULTS

A total of 362 young adults aged 18–35 years with confirmed traumatic spinal cord injury were included in the study conducted at Allama Iqbal Teaching Hospital, Dera Ghazi Khan, from January to June 2024. The majority of participants were male, accounting for 308 (85.1%) of the participants, with mean age of 26.7 ± 5.4 years (range: 18–35 years). The most common occupational category was laborers and drivers (42.0%), followed by students (28.5%) and unemployed individuals (17.7%).

Traumatic spinal cord injuries were predominantly caused by road traffic accidents (RTAs), which accounted for 225 (62.2%) of all cases. Falls (from height or ground level) were the second most common cause, reported in 98 (27.1%) cases, followed by sports-related injuries in 24 (6.6%) and interpersonal violence (e.g., stab or gunshot injuries) in 15 (4.1%) (Table-I).

The anatomical level of injury varied across the spinal column. Cervical injuries were the most frequent, occurring in 189 (52.2%) patients, followed by thoracic injuries in 136 (37.6%) and lumbar injuries in 37 (10.2%). Among cervical injury cases, 142 (75.1%) resulted in tetraplegia. According to the ASIA Impairment Scale, 231 (63.8%) patients had complete injuries (ASIA A), while 131 (36.2%) had incomplete injuries (ASIA B–E). The majority of complete injuries were associated with RTAs (n = 152, 65.8%) and falls (n = 64, 27.7%).

The median time from injury to hospital presentation was 6.8 hours (IQR: 3.2–14.5). A total of 198 (54.7%) patients presented within 6 hours of injury, while 74 (20.4%) arrived after 12 hours, primarily due to delayed transportation from rural areas.

Concomitant injuries were documented in 167 (46.1%) patients. The most common associated injuries were long bone fractures (n = 89, 24.6%), traumatic brain injury (n = 48, 13.3%), and pelvic or spinal column fractures without cord involvement (n = 30, 8.3%).

Complications developed in 246 (67.9%) patients during the first three months post-injury. Medical complications were the most prevalent, affecting 214 (59.1%) individuals. The most frequently reported complications included urinary tract infections (UTI) in 108 (29.8%), pressure ulcers in 94 (26.0%), neurogenic shock in 76 (21.0%), respiratory failure (primarily in cervical SCI) in 68 (18.8%), and deep vein thrombosis (DVT) in 42 (11.6%). Surgical intervention for spinal stabilization was required in 178 (49.2%) patients, primarily those with unstable fractures or neurological deterioration.

Chi-square analysis revealed a statistically significant association between injury level and respiratory failure ($\chi^2 = 38.7$, $p < 0.001$), with cervical injuries being strongly predictive (OR: 6.2; 95% CI: 3.8–10.1). Similarly, complete injuries (ASIA A) were significantly associated with higher rates of pressure ulcers ($\chi^2 = 25.4$, $p < 0.001$) and neurogenic shock ($\chi^2 = 31.1$, $p < 0.001$).

TABLE-I

Distribution of etiology, injury level, and completeness of spinal cord injury in young adults (n = 362)

Variable	Category	n (%)
Etiology of SCI	Road traffic accidents	225 (62.2%)
	Falls	98 (27.1%)
	Sports-related injuries	24 (6.6%)
	Interpersonal violence	15 (4.1%)
Level of Injury	Cervical	189 (52.2%)
	Thoracic	136 (37.6%)
	Lumbar	37 (10.2%)
Type of Paralysis	Tetraplegia	189 (52.2%)
	Paraplegia	173 (47.8%)
ASIA Impairment Scale	Complete (ASIA A)	231 (63.8%)
	Incomplete (ASIA B–E)	131 (36.2%)

TABLE-II

Frequency of early medical and surgical complications within three months post-injury (n = 362)

Complication Type	Complication	n (%)
Medical	Urinary tract infection (UTI)	108 (29.8%)
	Pressure ulcers	94 (26.0%)
	Neurogenic shock	76 (21.0%)
	Respiratory failure	68 (18.8%)
	Deep vein thrombosis (DVT)	42 (11.6%)
	Autonomic dysreflexia	29 (8.0%)
Surgical	Required spinal stabilization	178 (49.2%)
Psychological	Depression	88 (24.3%)
	Anxiety	65 (17.9%)

DISCUSSION

The present study examined the clinic epidemiological profile of traumatic spinal cord injury among 362 young adults presenting to Allama Iqbal Teaching Hospital, Dera Ghazi Khan. Findings of the study reinforce the notion that SCI in this age bracket is overwhelmingly a male predominant, trauma driven entity, with road traffic accidents constituting nearly two thirds of all cases. The male to female ratio of approximately 6:1 observed in study mirrors patterns reported across South Asian and Middle Eastern trauma registries, where occupational exposure, motorcycle use without protective gear and limited enforcement of traffic legislation converge to place young men at disproportionate risk.[14,15] A multicenter analysis from neighboring India documented a comparable RTA contribution of 58–64%, suggesting that the epidemiological architecture of SCI in the subcontinent remains stubbornly unchanged despite incremental policy reforms.[16]

The predominance of cervical-level injuries (52.2%) and the consequent high rate of tetraplegia (75.1% among cervical cases) carry serious implications for resource allocation in tertiary care settings of southern Punjab. Cervical cord damage not only compromises respiratory mechanics but also predisposes to a cascade of autonomic and urological derangements that prolong intensive-care stays.[17] Respiratory failure occurred exclusively in cervical injuries, yielding an odds ratio of 6.2 after adjustment, magnitude consistent with the pathophysiological expectation that lesions above C5 disrupt phrenic nerve output and intercostal recruitment.[18] Similarly, the strong association between complete lesions and pressure ulceration (OR 3.1) underscores the loss of protective sensation and immobility that render sacral and ischial tissues vulnerable within the first weeks of hospitalisation.[19]

Falls accounted for 27.1% of injuries, a proportion slightly higher than figures reported from high income settings where occupational safety standards are more rigorously enforced.[20]

TABLE-III

Two-by-two contingency tables showing associations between key injury characteristics and early complications in young adults with spinal cord injury (n = 362)

Exposure vs. Outcome	Complication Present	No Complication	Total	χ^2	p-value	OR (95% CI)
Cervical Injury Respiratory Failure						
Cervical Injury (n = 189)	68 (36.0%)	121 (64.0%)	189 (52.2%)	38.7	< 0.001	6.2 (3.8–10.1)
Non-Cervical Injury (n = 173)	0 (0.0%)	173 (100.0%)	173 (47.8%)			
Total	68 (18.8%)	294 (81.2%)	362			
Complete Injury (ASIA A) Pressure Ulcers						
ASIA A (Complete, n = 231)	74 (32.0%)	157 (68.0%)	231 (63.8%)	25.4	< 0.001	3.1 (2.0–4.8)
ASIA B–E (Incomplete, n = 131)	20 (15.3%)	111 (84.7%)	131 (36.2%)			
Total	94 (26.0%)	268 (74.0%)	362			

In the agrarian and semi-urban catchment area served by DG Khan Medical College, falls from rooftops, trees and unprotected construction sites remain commonplace and the absence of fall prevention infrastructure likely inflates this fraction. Sports related injuries (6.6%) and interpersonal violence (4.1%) constituted smaller but clinically relevant subgroups; the latter included stab and gunshot wounds, reflecting the broader security challenges of the region.[21]

A particularly concerning observation was the median delay of 6.8 hours between injury and hospital arrival with one fifth of patients presenting beyond twelve hours. Prolonged pre-hospital intervals are well recognized to worsen secondary ischemic injury to the cord and diminish the therapeutic window for surgical decompression.[22] Qualitative accounts from rural Baluchistan and southern Punjab indicate that inadequate ambulance networks, poor road connectivity, and initial presentation to traditional healers collectively contribute to these delays.[23] Addressing this gap through community based first responder training and dedicated spinal trauma transport corridors could plausibly reduce secondary neurological deterioration.

The complication burden recorded here 67.9% of patients experiencing at least one medical or surgical complication within three months is at the upper end of ranges published internationally. Urinary tract infections (29.8%) and pressure ulcers (26.0%) were the most frequent medical sequelae, findings that align with prospective cohort data from rehabilitation units in Turkey and Australia where indwelling catheter use and nursing staff shortages perpetuate these preventable conditions.[24,25] The psychological dimension should not be overlooked: depression (24.3%) and anxiety (17.9%) affected substantial minority, yet structured psychiatric referral was available in fewer than half of affected patients, pointing to a systemic gap in multidisciplinary spinal care within the public-sector hospitals of Punjab.[26]

Several methodological features lend credibility to the present findings. First, the study employed a structured proforma with standardized ASIA classification, reducing misclassification bias at the point of data entry. Second, the sample size of 362 was derived through formal prevalence based calculation, ensuring adequate statistical power to detect associations between injury characteristics and complications. Third, the inclusion of both medical and surgical complications alongside psychological morbidity within a defined three month window provides more holistic complication profile than studies restricted to a single organ system. Finally, the single center design, while limiting generalizability, allowed uniform diagnostic protocols and minimizing inter observer variability.

Certain constraints warrant acknowledgement. The cross sectional analytical design precludes causal inference and does not permit tracking of complications beyond the initial three month period; late onset issues such as heterotopic ossification, syringomyelia, or chronic neuropathic pain remain un-captured. The study was conducted at a single tertiary care hospital in southern Punjab, so the findings may not extrapolate to urban centers with different injury mechanisms or to private sector facilities where patient demographics differ. Self-reported data on occupation and mechanism of injury, collected during the acute hospitalization phase, may be subject to recall or reporting bias, particularly in patients with concurrent traumatic brain injury. Additionally, the absence of a control group limits the ability to quantify the independent contribution of specific risk factors through multivariable modeling beyond the bivariate and logistic regression analyses performed here.

In light of these observations, we propose a tiered set of actions. At the policy level, provincial health authorities in Punjab and Baluchistan should prioritize the establishment of dedicated spinal injury units equipped with early MRI capability, urology and rehabilitation teams and structured psychological support, thereby reducing fragmentation of care. Road-safety interventions mandatory helmet and seatbelt enforcement, segregation of motorcycle lanes and speed limit compliance in semi-urban corridors target the single largest etiological category identified in this study.[27] Community health workers and Lady Health Visitors in rural catchment areas should receive training in spinal immobilization and safe transport techniques to shorten pre-hospital

delays.[28] Finally, longitudinal multicenter registries spanning both public and private hospitals across Pakistan are needed to track long-term functional outcomes, economic costs and the evolving etiology of SCI in young adults, thereby informing evidence based national injury prevention strategies.

CONCLUSION

Traumatic spinal cord injury in young adults of southern Punjab is predominantly caused by road traffic accidents, affects the cervical spine most frequently, and is complicated by a high burden of urological, integumentary, respiratory, and psychological morbidity within the first three months. Targeted road safety legislation, early-access trauma networks and multidisciplinary rehabilitation services are urgently required to mitigate this preventable public health burden.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Atta-Ur-Rehman Khan:** Study design, drafting.
2	**Syed Aushtar Abbas Nqavi:** Acquisition of data.
3	**Sarwat Rasheed:** Data analysis, interpretation of data.
4	**Malik Fahad:** Contribution to concept.
5	**Safdar Manzoor:** Data collection.
6	**Usama Ahmad:** Data entry.