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Epidemiology of traumatic spinal injuries in a low-resource setting: a retrospective cohort from southwestern Iran

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Abstract

Objective Traumatic spinal injuries (TSIs) impose severe disability and healthcare burden in low-resource settings, yet comprehensive epidemiological data from southwestern Iran—specifically Khuzestan province with the nation's highest road traffic mortality rate (32.5 per 100,000)—remain critically scarce. This retrospective cohort study characterizes the demographic profiles, etiological mechanisms, anatomical distributions, neurological outcomes, laboratory correlates, and clinical trajectories of TSI patients admitted to Ganjavian Hospital, a high-volume Level-II trauma center serving this underserved region from January 2022 to March 2024.

Results Among 759 patients with radiologically confirmed TSIs (72.5% male; mean age 39.5 ± 12.7 years), motor vehicle collisions dominated etiology (60.1%), followed by falls (28.6%). Cervical spine was most affected (50.7%), followed by thoracic (40.6%) and lumbar (17.4%) regions. Neurological deficits occurred in 20.8% (complete motor/sensory loss 11.6%, partial deficits 7.2%). Mean length of stay was 4.3 days (range 1–46); in-hospital mortality was 2.9% ($n=22$, all cardiac arrest). Cervical injuries correlated with longer stays (5.2 vs. 4.1 days thoracic, $p=0.041$); injury mechanisms predicted anatomical sites ($p=0.027$); initial GCS showed no mortality association ($p=0.756$). However, BUN ($r=0.41$) and creatinine ($r=0.38$) moderately predicted hospitalization duration ($p<0.05$), suggesting utility as pragmatic risk markers where advanced monitoring is unavailable.

Keywords Traumatic spinal injury, Spinal trauma, Cervical spine, Motor vehicle collision, Low-resource setting, Epidemiology

Introduction

Trauma remains a leading cause of death and disability worldwide, accounting for over 5 million fatalities annually—disproportionately affecting low- and middle-income countries (LMICs), where road traffic injuries (RTIs) constitute the dominant mechanism. In Iran, RTIs alone claim approximately 24,000 lives each year [1], with a substantial proportion of trauma-related deaths occurring before hospital arrival due to underdeveloped pre-hospital emergency care systems [2].

Among trauma-related conditions, traumatic spinal injuries (TSIs) defined as fractures, dislocations, or

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ligamentous disruptions of the vertebral column—are among the most devastating, often resulting in permanent neurological impairment, chronic pain, and profound socioeconomic consequences [3]. While a subset of TSIs involves spinal cord damage (i.e., traumatic spinal cord injury, or SCI), the broader spectrum of spinal trauma significantly impacts both young adults (typically through high-energy mechanisms such as motor vehicle collisions) and older individuals with degenerative spinal disease [4]. Globally, the incidence of traumatic SCI is estimated at 10.5 per 100,000 population [5], with markedly higher rates reported in the Middle East and North Africa [6]. A recent systematic review from Iran estimated SCI incidence between 40 and 50 per million, with motor vehicle collisions and falls identified as the leading causes [7].

The cervical spine is the most commonly affected region, frequently leading to quadriplegia and respiratory compromise, whereas thoracic injuries are more often associated with paraplegia and autonomic dysfunction [8]. Despite advances in acute care and rehabilitation, outcomes in resource-limited settings remain suboptimal, largely due to delays in specialized intervention, limited access to imaging, and fragmented post-acute support [9].

While national registries like the National Spinal Cord Injury Registry of Iran (NSCIR-IR) [7, 10] and studies from major urban centers (Tehran, Isfahan, Shiraz) have advanced our understanding of spinal trauma epidemiology in Iran, critical gaps persist regarding low-resource settings. Khuzestan province—characterized by the nation's highest road traffic mortality rate (32.5 per 100,000), limited prehospital infrastructure, and pronounced seasonal injury patterns—remains entirely unrepresented in the literature. Unlike registry-based studies that often exclude minor injuries or lack granular clinical data, our real-world cohort captures the full spectrum of spinal trauma in a Level-II trauma center with constrained resources, offering unique insights into documentation practices, comorbidity burdens, and pragmatic risk stratification using routinely available markers (e.g., BUN, creatinine). This context-specific evidence is essential for developing regionally tailored prevention and care pathways in similar underserved settings across the Middle East.

Methods

This retrospective cohort study was conducted at ..., a Level-II trauma center in The study population comprised patients admitted to the emergency department between January 2022 and March 2024 with a diagnosis of traumatic spinal injury (TSI).

Medical records of 1,013 consecutive patients were initially screened. Inclusion criteria were: (1) radiologically

confirmed spinal trauma (via computed tomography or plain radiography), and (2) complete clinical documentation, including Glasgow Coma Scale (GCS) score on admission. Exclusion criteria included missing imaging studies or incomplete GCS records. Following application of these criteria, 759 patients were included in the final analysis. A total of 254 records were excluded: 150 due to absent imaging and 104 due to incomplete GCS documentation.

Data were extracted using a structured, pilot-tested checklist developed in consultation with trauma surgeons and neurosurgery specialists. The instrument captured three domains of variables: Demographics: age, sex, marital status, body mass index (BMI), and preexisting comorbidities (e.g., hypertension, diabetes mellitus, cardiovascular disease);

Injury characteristics: mechanism (e.g., motor vehicle collision, fall from height, assault), time and season of injury, anatomical level of spinal involvement (cervical, thoracic, lumbar), fracture type (e.g., lamina, transverse process, burst), initial GCS score, and duration of hospitalization;

Neurological status was assessed retrospectively through clinical documentation rather than prospective evaluation using the American Spinal Injury Association (ASIA) Impairment Scale. This methodological limitation was unavoidable due to the retrospective nature of the study and the lack of standardized neurological documentation protocols in our institution's routine clinical practice. We acknowledge that this approach may introduce misclassification bias in neurological deficit reporting.

Laboratory findings: including complete blood count (CBC), serum electrolytes, international normalized ratio (INR), arterial blood pH, blood urea nitrogen (BUN), and serum creatinine (Cr)—were selected not for their direct pathophysiological link to spinal trauma, but because they represent the only routinely available objective data for risk stratification in our resource-constrained setting. Their prognostic value for outcomes such as length of stay and mortality was therefore evaluated as part of a pragmatic approach to clinical decision-making where advanced monitoring is unavailable.

To ensure data reliability and minimize selection bias, all records were independently reviewed by two trained researchers blinded to the study objectives. Discrepancies were resolved through consensus or, when necessary, by a third reviewer.

The study was approved by the Ethics Committee of Dezfoul University of Medical Sciences (Approval Code: IR.DUMS.REC.1400.044). Patient confidentiality was maintained by removing all personal identifiers prior to analysis. Informed consent was waived due to the retrospective design.

Statistical analyses were performed using IBM SPSS Statistics, version 22 (IBM Corp., Armonk, NY, USA). Continuous variables are reported as mean $\pm$ standard deviation (SD), and categorical variables as frequencies and percentages. Group comparisons for continuous outcomes were conducted using independent t-tests (for two groups) or one-way ANOVA (for ≥ 3 groups). Associations between categorical variables (e.g., injury mechanism and spinal level) were assessed using Chi-square tests. Pearson correlation coefficients (r) were calculated to evaluate linear relationships between continuous variables (e.g., BUN or creatinine levels and length of stay). A two-tailed p -value < 0.05 was considered statistically significant.

Results

Demographic characteristics

A total of 759 patients with radiologically confirmed traumatic spinal injuries were included in the analysis. The cohort was predominantly male (550 patients, 72.5%), yielding a male-to-female ratio of 2.6:1. The mean

age was 39.5 ± 12.7 years (range: 2–76 years), with 53.6% of patients aged ≤ 38 years. Most participants were married (594, 78.3%), and 21.7% were single.

The mean body mass index (BMI) was 26.5 ± 3.1 kg/m², consistent with an overweight population according to WHO classification. Substance use was rare: only five patients reported cigarette smoking, and two disclosed opium use.

Preexisting medical conditions were common, with hypertension (17.2%), hypercholesterolemia (9.8%), and type 2 diabetes mellitus (8.8%) being the most prevalent comorbidities. A detailed summary of demographic and clinical characteristics is provided in Table 1.

Clinical information

The predominant mechanism of traumatic spinal injury was motor vehicle collisions (MVCs), accounting for 60.1% of cases, followed by falls from height (28.6%). Interpersonal violence and physical altercations were the least common causes, representing only 3.8% of injuries (Fig. 1).

Clinically, neck pain was the most frequently reported symptom (50.7%), consistent with the high prevalence of cervical spine involvement. This was followed by chest and back pain (40.6%) and isolated back pain (17.4%). Additional symptoms—including headache, nausea, and vomiting—were less common. Notably, 98% of patients developed symptoms immediately following the traumatic event.

Regarding prehospital care, 62% of patients were transported via official emergency medical services (EMS), while 38% arrived by private vehicle. Injury incidence showed seasonal variation, peaking in summer (33.3%) and autumn (30.4%), with the majority of emergency department admissions occurring during morning and afternoon hours (Table 2).

The mean hospitalization duration was 4.3 days (range: 1–46 days). On admission, the mean Glasgow Coma Scale (GCS) score was 14.8 (range: 9–15), with minimal change by day three (mean: 14.7; range: 7–15). Despite the average length of stay, a substantial proportion of patients were discharged within 24 h, reflecting the inclusion of both minor and severe injuries.

Cervical spine involvement was the most common anatomical pattern (50.7%). All in-hospital deaths ($n = 22$, 2.9%) were attributed to cardiac arrest. Consistent with statistical analysis, no significant association was observed between initial GCS score and mortality ($p = 0.756$), suggesting that fatalities resulted from systemic complications rather than primary neurological impairment.

Table 1 Demographic and clinical background of patients with traumatic spinal injury ($n = 759$)

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	550	72.5
	Female	209	27.5
Age Group	2–38 years	407	53.6
	39–76 years	352	46.3
	Mean $\pm$ SD	39.5 ± 12.7 years	—
Marital Status	Married	594	78.2
	Single	165	21.7
Preexisting Comorbidities	Hypertension	131	17.2
	Hypothyroidism	45	5.9
	Hyperthyroidism	12	1.5
	Diabetes Mellitus Type 1	22	2.8
	Diabetes Mellitus Type 2	67	8.8
	Cardiovascular Disease	32	4.2
	Hypercholesterolemia	75	9.8
	Asthma	9	1.1
	Osteoporosis	14	1.8
	Rheumatoid Arthritis	10	1.3
Familial History	Hypertension	64	8.4
	Diabetes Mellitus Type 1	34	4.4
	Diabetes Mellitus Type 2	63	8.3
	Cardiovascular Disease	97	12.7
	Hypercholesterolemia	56	7.3
	Osteoporosis	5	0.6
	Rheumatoid Arthritis	2	0.2
	Cancer	24	3.1

Note: Age groups were dichotomized at the median value (38 years)

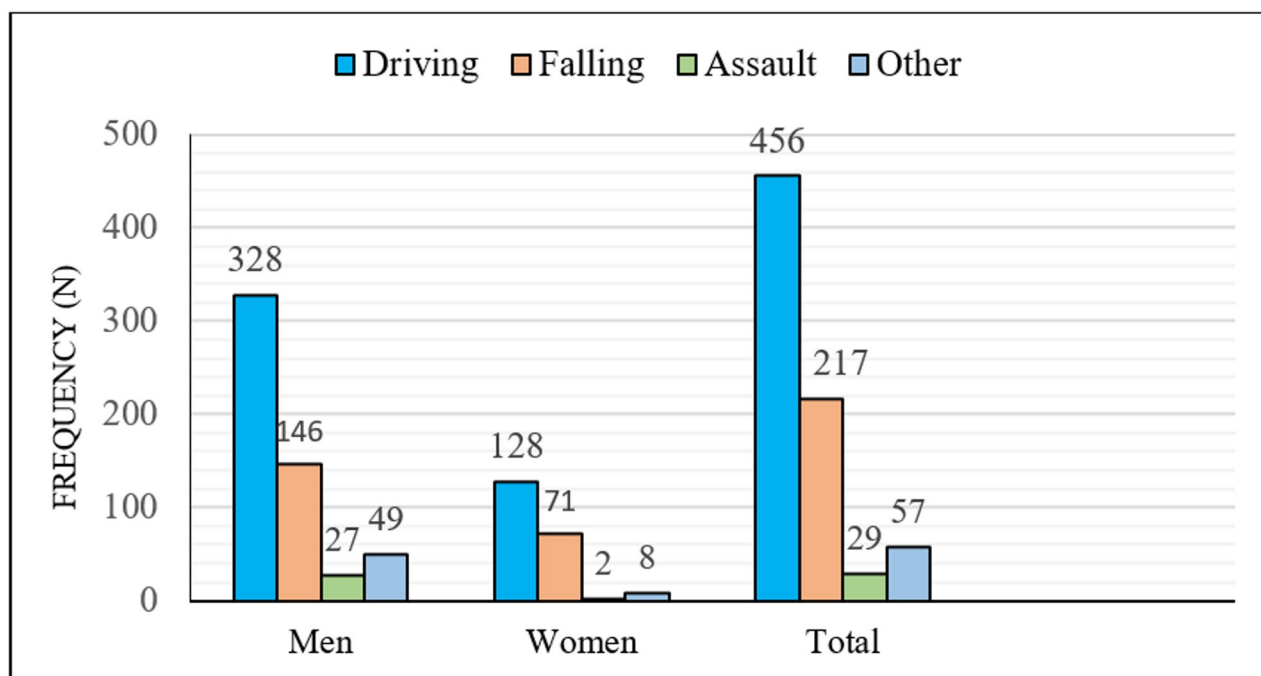


Fig. 1 Distribution of Spinal Fracture Types Evaluated by Computed Tomography in Trauma Patients

Table 2 Seasonal distribution, time of injury, Glasgow Coma Scale (GCS) scores, clinical outcomes, and anatomical location of spinal injuries among 759 patients

Season of injury	Spring	165	21.7
	Summer	253	33.3
GCS on admission (Day 1)	Fall	231	30.4
	Winter	110	14.5
	9	11	1.4
	11	11	1.4
GCS on Day 3	14	22	2.9
	15	704	92.8
	7	11	1.4
	9	11	1.4
Clinical outcome	14	11	1.4
	15	726	95.7
	Complete improvement	517	68.1
	Partial recovery	198	26.1
Anatomical level of injury	Death	22	2.9
	Transferred to higher-level facility	22	2.9
	Cervical	385	50.7
	Thoracic	308	40.6
	Lumbar	132	17.4

Note: Percentages may not sum to 100% due to rounding. *GCS = Glasgow Coma Scale

Imaging findings and clinical statistics

Computed tomography (CT) was the primary imaging modality used for the evaluation of spinal trauma at Dr. Ganjavian Hospital, guiding clinical decision-making and treatment planning in the majority of cases. Fracture

types were documented using descriptive anatomical terminology (e.g., lamina, transverse process) as per our institution's standard radiology reporting protocol, as formal classification systems (AO Spine, TLICS) are not routinely implemented in our setting. The most prevalent fracture pattern was vertebral lamina fracture (39%), followed by transverse process fractures (24%), fracture-dislocation injuries (13%), spinous process fractures (11%), compression fractures (10%), and burst fractures (3%), as illustrated in Fig. 2. While this descriptive approach reflects real-world clinical documentation practices in our resource-limited context, we acknowledge it limits direct comparison with studies utilizing standardized classification systems (Tables 3, 4 and 5).

Seasonal distribution, level of consciousness, clinical outcomes, and anatomical injury patterns

Injury incidence showed marked seasonal variation, with the highest frequency occurring in summer (33.3%), followed by autumn (30.4%), spring (21.7%), and winter (14.5%). Emergency department admissions peaked during morning and afternoon hours, consistent with patterns of daily activity and traffic exposure.

Upon admission, the Glasgow Coma Scale (GCS) scores were predominantly normal: 92.8% of patients scored 15, while 2.9% scored 14, and 1.4% each scored 11 or 9. By day three, neurological status remained stable or improved, with 95.7% of patients scoring 15; isolated cases scored 14, 9, or 7 (each 1.4%).

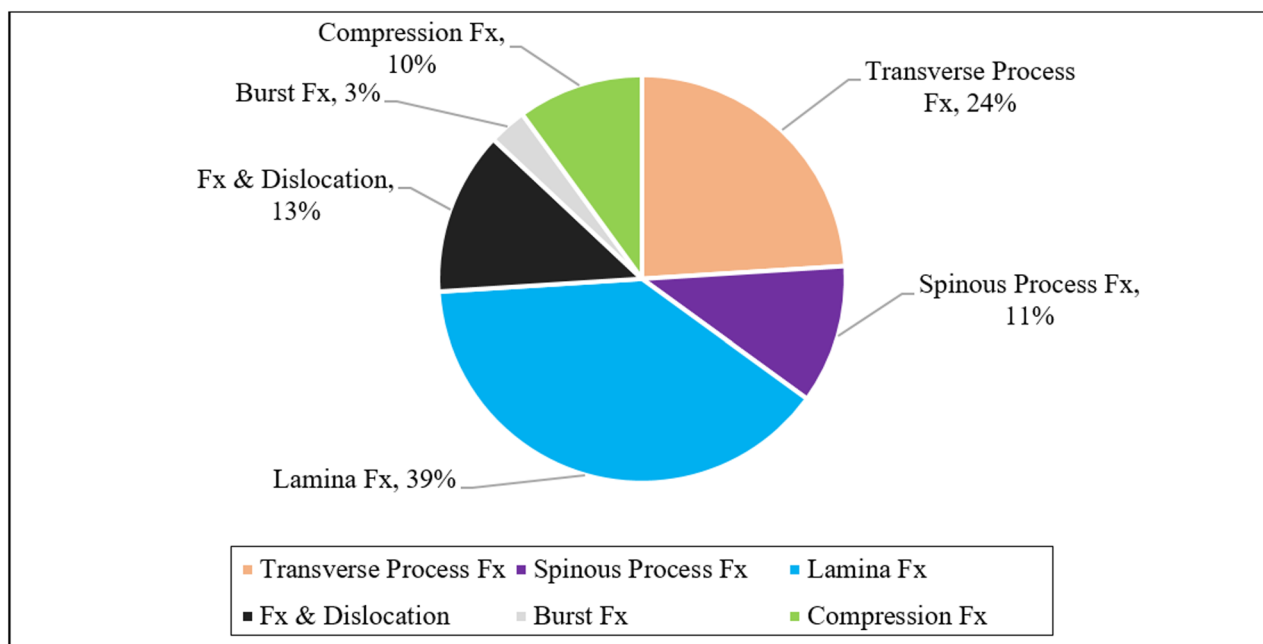


Fig. 2 Distribution of Glasgow Coma Scale (GCS) Scores Among Trauma Patients

* GCS: Glasgow Coma Scale

Table 3 Summary of Laboratory Test Results

Variable	Mean	Standard Deviation	Missing Values (n)
White Blood Cells (WBC, $\times 10^9/L$)	12.5	5.3	22
Red Blood Cells (RBC, $\times 10^{12}/L$)	4.8	1.1	22
Hemoglobin (Hb, g/dL)	13.3	1.8	22
Platelets (PLT, $\times 10^9/L$)	216	59.6	22
Prothrombin Time (PT, sec)	14.1	1.7	484
Partial Thromboplastin Time (PTT, sec)	30.7	4.2	484
International Normalized Ratio (INR)	1.2	1.2	484
Blood Sugar (BS, mg/dL)	123.6	34.7	22
Blood Urea Nitrogen (BUN, mg/dL)	16.0	4.6	22
Creatinine (Cr, mg/dL)	0.95	0.19	22
Sodium (Na, mmol/L)	139.4	2.9	44
Potassium (K, mmol/L)	4.1	0.3	44
Calcium (Ca, mg/dL)	8.8	0.5	484
Phosphorus (mg/dL)	3.4	1.2	506
Urine Specific Gravity (Urine S.G)	10.20	0.006	506
Blood pH	7.4	0.05	22

Regarding clinical outcomes, the majority of patients achieved complete improvement (68.1%), while 26.1% experienced partial recovery. In-hospital mortality was 2.9% ($n=22$), with all deaths attributed to cardiac arrest. An additional 2.9% ($n=22$) were transferred to higher-level facilities for advanced neurosurgical or critical care.

The cervical spine was the most frequently injured region (50.7%), followed by the thoracic spine (40.6%) and lumbar spine (17.4%). This distribution aligns with the high prevalence of motor vehicle collisions and the

Table 4 Distribution of Neurological Deficits Among Patients with Spinal Injuries

Type of Deficit	Description	Frequency (n)	Percentage (%)
Complete Motor and Sensory Loss	Total paralysis and loss of sensation below the level of injury	88	11.6%
Partial Neurological Deficits	Asymmetric weakness, localized sensory loss, or incomplete motor impairment	55	7.2%
Transient Neurological Symptoms	Temporary symptoms (e.g., numbness, tingling) resolved within 72 h	15	2.0%
Any neurological deficit	Total of all documented deficits	158	20.8%
No documented neurological deficit	No neurological symptoms reported or documented	601	79.2%

biomechanical vulnerability of the cervical segment in high-energy trauma.

Laboratory findings

Routine laboratory parameters—including complete blood count (CBC), international normalized ratio (INR), blood urea nitrogen (BUN), serum creatinine (Cr), and electrolytes—showed no significant association with in-hospital mortality or major clinical outcomes (all $p > 0.05$).

However, length of hospital stay demonstrated moderate positive correlations with BUN ($r=0.41$) and creatinine ($r=0.38$), both of which were statistically significant

Table 5 Statistical associations between key clinical variables in patients with traumatic spinal injurie

Variable Pair	Test Used	p-value	Key Finding
Level of Injury and Duration of Hospitalization	ANOVA	0.041	Patients with cervical injuries had significantly longer hospital stays (mean = 5.2 days) compared to those with thoracic (4.1 days) or lumbar (3.6 days) injuries
Initial GCS Score and In-Hospital Mortality	Chi-square	0.756	o statistically significant association was found; most deceased patients had a GCS of 15 on admission, suggesting mortality was driven by systemic complications (e.g., cardiac arrest) rather than initial consciousness level.
Mechanism of Injury and Anatomical Level of Injury	Chi-square	0.027	Motor vehicle collisions were significantly associated with cervical and thoracic spine injuries, whereas falls from height were more commonly linked to lumbar spine involvement.

($p < 0.05$). These findings suggest that elevated BUN and creatinine levels may reflect systemic stress, dehydration, or prolonged immobilization rather than primary renal dysfunction, and could serve as surrogate markers for extended hospitalization in patients with traumatic spinal injury.

Neurological deficits

Neurological impairments were reported in 20.8% of patients ($n = 158$), as documented in clinical records—though without standardized ASIA grading. Neurological deficits were identified through retrospective review of clinical notes, which contained descriptive assessments (e.g., ‘quadriplegia,’ ‘sensory loss below T6’) rather than structured evaluations using the American Spinal Injury Association (ASIA) Impairment Scale. This approach—while reflecting real-world documentation practices in our setting—carries a high risk of misclassification and limits the precision of neurological characterization. We explicitly acknowledge that the reported 20.8% prevalence of neurological deficits should be interpreted as an estimate of clinical burden rather than a reliable measure of injury severity or functional impairments.

Cervical injuries (50.7% of all spinal injuries) most commonly presented with quadriplegia, upper limb weakness, and respiratory compromise, particularly when high cervical segments (C3–C5) or the phrenic nerve were involved.

Thoracic injuries (40.6%) were predominantly associated with paraplegia, sensory loss below the injury level,

and autonomic dysfunction, including bladder and bowel impairment.

Lumbar injuries (17.4%) were less frequently linked to complete motor deficits but often manifested as radicular pain, lower limb sensory disturbances, or features of cauda equina syndrome—such as saddle anesthesia, urinary retention, or incontinence.

These patterns reflect the neuroanatomical organization of the spinal cord and are consistent with global reports on trauma-related neurological sequelae.

Statistical associations between clinical variables

To identify clinically meaningful relationships, we performed inferential analyses using one-way ANOVA for continuous outcomes and Chi-square tests for categorical associations.

Spinal injury level was significantly associated with length of hospital stay ($p = 0.041$). Patients with cervical injuries had the longest admissions (5.2 ± 3.1 days), compared to those with thoracic (4.1 ± 2.6 days) or lumbar injuries (3.6 ± 2.2 days). This gradient likely reflects the greater complexity of cervical trauma, including higher risks of respiratory compromise, need for immobilization, and multidisciplinary monitoring.

Initial Glasgow Coma Scale (GCS) score showed no association with in-hospital mortality ($p = 0.756$). Remarkably, most patients who died ($n = 22$) had a GCS of 15 on admission, reinforcing that mortality in isolated spinal trauma is primarily driven by systemic complications—such as cardiac arrest—rather than depressed consciousness or concomitant traumatic brain injury.

Trauma mechanism was significantly linked to anatomical injury site ($p = 0.027$). Motor vehicle collisions were strongly associated with cervical and thoracic spine injuries, consistent with high-energy axial loading and flexion-extension forces. In contrast, falls from height were more frequently related to lumbar fractures, likely due to vertical compression forces transmitted through the spine upon impact.

Discussion

To our knowledge, this is the first comprehensive epidemiological study of traumatic spinal injuries from Khuzestan province—a high-trauma, low-resource region with the highest road traffic fatality rate in Iran. Unlike prior Iranian studies based in metropolitan centers [3, 7, 10], our cohort reflects the realities of a mid-sized city with constrained neurosurgical resources, absent standardized neurological documentation (ASIA protocol), and pronounced seasonal variation in injury incidence. Three novel contributions distinguish our work: First, we demonstrate that initial GCS has no prognostic value for mortality in isolated spinal trauma—a critical insight for resource allocation in settings where

GCS is routinely prioritized. Second, we identify moderate correlations between routine laboratory markers (BUN, creatinine) and hospitalization duration, suggesting their utility as surrogate indicators of clinical complexity when advanced monitoring is unavailable. Third, we quantify the substantial burden of comorbidities (hypertension 17.2%, diabetes 8.8%) among TSI patients in low-resource settings—a neglected dimension that significantly impacts secondary complication risks and rehabilitation potential. These findings collectively underscore the need for context-specific trauma protocols that transcend ‘one-size-fits-all’ approaches derived from high-income setting.

A striking male predominance (72.5%; male-to-female ratio $\approx$ 2.6:1) was observed, consistent with global patterns in spinal trauma [3, 11]. This disparity likely reflects higher exposure to occupational and traffic-related risks among Iranian men, compounded by lower adherence to safety measures such as seatbelt use [1]. Similar ratios have been reported across the Middle East and South Asia, including studies from Turkey (2.3:1) [12], Saudi Arabia (3.1:1) [12, 13], and India (3.8:1) [14], underscoring a regional public health challenge.

Motor vehicle collisions (MVCs) accounted for 60.1% of injuries, emerging as the dominant etiology—slightly lower than national Iranian estimates (63–68%) [3, 7] but markedly higher than rates in high-income countries ($< 40\%$). This burden aligns with WHO data identifying Iran as having one of the highest road traffic fatality rates globally (32.5 per 100,000 population) [1]. The predominance of MVCs—particularly among young males—highlights an urgent need for **context-specific road safety interventions**, including mandatory helmet laws for motorcyclists (who constitute $> 50\%$ of MVC victims in Khuzestan, stricter drunk-driving enforcement, and road infrastructure upgrades.

Cervical spine involvement (50.7%) was the most common anatomical pattern, consistent with biomechanical vulnerability during high-energy impacts. Notably, cervical injuries were associated with significantly longer hospital stays (5.2 vs. 4.1 days for thoracic; $p = 0.041$), likely due to risks of respiratory compromise, need for rigid immobilization, and multidisciplinary monitoring—findings echoed in a multicenter Indian study [14]. Furthermore, MVCs were strongly linked to cervical/thoracic injuries, whereas falls predominantly affected the lumbar spine ($p = 0.027$), reflecting distinct energy-transfer mechanisms: axial loading in MVCs versus vertical compression in falls [15].

Critically, initial GCS score showed no association with mortality ($p = 0.756$), and 92.8% of deceased patients had GCS = 15 on admission. This confirms that in isolated spinal trauma—without concomitant traumatic brain injury—GCS has limited prognostic value for mortality.

Instead, all 22 deaths resulted from cardiac arrest, likely secondary to autonomic dysreflexia, pulmonary embolism, or sepsis—systemic complications well-documented in LMIC settings with fragmented critical care [8].

The high prevalence of chronic comorbidities—notably hypertension (17.2%) and type 2 diabetes (8.8%)—mirrors Iran’s national non-communicable disease burden [16]. These conditions exacerbate secondary complications (e.g., pressure ulcers, urinary infections) and impair rehabilitation outcomes [4]. Even osteoporosis (1.8%), though seemingly low, may predispose older adults to severe fractures after minor trauma—a pattern observed in European cohorts [17].

While routine laboratory markers (CBC, INR, electrolytes) showed no association with mortality, BUN ($r = 0.41$) and creatinine ($r = 0.38$) demonstrated moderate positive correlations with length of hospital stay ($p < 0.001$). In the absence of advanced monitoring tools, these readily available markers may serve as pragmatic surrogates for systemic stress, dehydration, or prolonged immobilization—factors that indirectly prolong hospitalization in TSCI patients. This finding supports a context-adapted approach to risk stratification in low-resource settings where specialized neurological or imaging resources are unavailable [9].

In summary, TSIs in southwestern Iran are driven by preventable MVCs, disproportionately affect young males, and carry a high burden of cervical trauma and comorbidity. These findings call for integrated strategies: (1) primary prevention through road safety legislation, (2) secondary prevention via prehospital spinal immobilization protocols, and (3) tertiary prevention through comorbidity management and early rehabilitation. Establishing a national spinal injury registry—as piloted in Tehran [8]—is essential to monitor trends and evaluate interventions.

Conclusion

Our study provides the first epidemiological characterization of traumatic spinal injuries in Khuzestan province—southwestern Iran’s most underserved region. Among 759 patients, traumatic spinal injuries predominantly affected young males and were mainly caused by motor vehicle collisions (60.1%), with cervical spine involvement in over half of cases (50.7%). Neurological deficits were documented in 20.8% of patients, though assessed without standardized ASIA grading. Initial Glasgow Coma Scale score showed no association with in-hospital mortality, while elevated BUN and creatinine levels moderately correlated with longer hospital stays. These findings reflect the distinct clinical and systemic profile of spinal trauma in a low-resource, high-trauma setting.

Limitations and suggestions for future research

This study has several important limitations inherent to its retrospective design and the resource-constrained context in which it was conducted.

First, neurological deficits were identified solely through retrospective review of unstructured clinical notes, without application of the American Spinal Injury Association (ASIA) Impairment Scale or any other validated neurological grading system. This methodological gap significantly increases the risk of misclassification—particularly for incomplete syndromes, transient deficits, or subtle sensory impairments—and limits the precision of our reported 20.8% neurological deficit rate. Consequently, the neurological findings should be interpreted as a qualitative indicator of clinical burden, not a reliable quantitative measure of injury severity or functional prognosis.

Second, fracture patterns were documented using descriptive anatomical terminology (e.g., lamina, transverse process) rather than established classification systems such as AO Spine or TLICS. This reflects the current reality of radiology reporting in our institution and many similar trauma centers across southwestern Iran, where standardized fracture classification protocols are not yet integrated into clinical workflows. While this approach captures the heterogeneity of injury types, it reduces the scientific comparability of our data with international studies and precludes correlation of fracture morphology with stability or management decisions.

Third, reliance on hospital records may have introduced missing or inconsistent documentation, particularly regarding long-term functional outcomes, rehabilitation progress, and late-onset complications. Additionally, the cross-sectional nature of laboratory data (e.g., BUN, creatinine) limits causal interpretation of their association with length of stay.

Despite these constraints, our findings reflect the real-world epidemiology of traumatic spinal injuries in a low-resource, high-trauma setting—a context critically underrepresented in the global literature. To address these gaps, we strongly recommend that future studies in Iran adopt prospective, multicenter designs with standardized data collection protocols. Key improvements should include:

Mandatory use of the ASIA Impairment Scale at admission and during follow-up,

Integration of AO Spine or TLICS classification in radiology reporting,

Collection of patient-reported outcomes (e.g., Spinal Cord Independence Measure),

Exploration of novel biomarkers (e.g., neurofilament light chain, GFAP) for early prognostication.

At the health system level, expanding Iran's national trauma registry to include a dedicated spinal injury

module, establishing multidisciplinary care pathways (neurosurgery, rehabilitation, endocrinology, mental health), and implementing long-term follow-up programs are essential steps toward improving outcomes for this vulnerable population.

Acknowledgements

The authors gratefully acknowledge the management and clinical staff of Dr. Ganjavian Hospital in Dezful for their invaluable support and cooperation during data collection.

AI tool usage disclosure

ChatGPT was used exclusively for: English grammar and syntax corrections- Sentence restructuring for clarity- Minor wording improvements for readability. ChatGPT did NOT contribute to: Study design/methodology- Data collection/analysis (SPSS statistics)- Results interpretation- Scientific content/ conclusion- Figure/table creation.

Author contributions

All authors contributed to the conception and design of the study. Data collection and material preparation were carried out by M.F., M.K., B.Z., Z.K., and Y.A. The first draft of the manuscript was written by M.F., with critical revisions and intellectual input from all co-authors. designed the figures and tables. All authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Funding

This research was non-financially supported by Dezful University of Medical Sciences, Iran.

Data availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Approved by the Research Ethics Committee of Dezful University of Medical Sciences, Iran (Approval Code: IR.DUMS.REC.1400.044). Informed consent was waived by the Ethics Committee due to the retrospective nature of the study, in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 30 October 2025 / Accepted: 12 February 2026

Published online: 25 February 2026

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