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A RESEARCH ARTICLE

Biochemical, Epidemiological, and Neurological Patterns of Spinal Cord Injury in Iraq: A 23-Year Retrospective Hospital-Based Study to Inform Public Health and Rehabilitation Planning

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Abstract

Background: Spinal cord injuries (SCIs) and disorders are neurological conditions that impose a long-term health and functional burden, as they cause long-term motor and sensory deficits, a decline in independence and quality of life, and an ongoing need for specialized medical and rehabilitative services. Studying these conditions in the Iraqi context is particularly important, given the overlap between traditional traumatic injuries and those associated with violence, war, and non-traumatic medical causes. **Objective:** This study aimed to characterize the demographic, etiological, and neurological features of cases of spinal cord injuries and disorders referred to a referral rehabilitation center in Iraq, analyze changes in their patterns over time, and identify factors associated with the most severe neurological pattern at admission. **Methodology:** A retrospective observational study was conducted at the Ibn al-Kuaff Spinal cord injury hospital in Baghdad, based on a long-term database spanning from 2003 to the end of the study period. The study included 4,873 unique records, and the data underwent cleaning and standardization of clinical and etiological terminology. Demographic, etiological, and neurological variables were analyzed, Temporal trends in annual admissions were examined using negative binomial regression, while factors associated with quadriplegia/tetraplegia were assessed using multivariable binary logistic regression.**Results:** The results showed a clear male predominance at 92.1%, with a median age of 32 years. Injuries related to violence and war were the most common cause at 32.6%, followed by non-traumatic/medical causes, then falls and road traffic accidents. SCI was predominantly of the paraplegic type (85.0%), compared to 14.2% for quadriplegia/tetraplegia. The temporal analysis also showed a significant decline in annual admissions, with a clear shift in the distribution of causes across time periods. In the multivariable logistic regression analysis, increasing age was independently associated with higher odds of quadriplegia/tetraplegia (OR 1.007, 95% CI 1.002–1.012; p = 0.006), whereas sex, broad etiological category, and study period were not independently associated with neurological presentation.**Conclusion:** The study reveals a substantial and time-varying rehabilitation burden for spinal cord injuries and disorders in Iraq, characterized by a male predominance, a concentration in working-age adults, and a prominence of injuries associated with violence and war. The findings support the need for more detailed national registries linking epidemiological characteristics to long-term functional outcomes.

1. Introduction

Spinal cord injuries (SCIs) and related spinal cord disorders are among the most devastating neurological conditions, resulting in varying degrees of motor, sensory, and autonomic impairment that frequently lead to permanent disability, reduced functional independence, diminished quality of life, and substantial long-term healthcare needs [1–3]. Beyond the acute phase, individuals with SCI often require prolonged multidisciplinary rehabilitation, prevention of secondary complications, psychosocial support, and community reintegration, placing a considerable burden on patients, caregivers, and healthcare systems. Recent evidence has further demonstrated that the impact of SCI extends beyond neurological impairment to include significant socioeconomic consequences, increased healthcare expenditures, and long-term reductions in health-related quality of life [3-6]. Consequently, understanding the epidemiological characteristics of SCI is essential for healthcare planning, prevention strategies, and optimization of rehabilitation services [1–6].

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Globally, the epidemiology of SCI demonstrates substantial variation across countries and regions. Differences in incidence, demographic characteristics, mechanisms of injury, and neurological presentation are influenced by socioeconomic conditions, healthcare infrastructure, transportation systems, occupational hazards, population aging, and the prevalence of violence or armed conflict [3]. Although road traffic accidents and falls remain the predominant causes of SCI in many high-income countries, the relative contribution of violence-related injuries and non-traumatic spinal cord disorders differs considerably between geographical settings. Furthermore, males consistently account for the majority of SCI cases, while young and middle-aged adults represent the most affected population in most epidemiological reports [1–4].

The epidemiological profile of SCI varies from what has been reported in many developed countries in the Middle East due to the differences in the mechanisms of trauma, demographics, healthcare delivery systems, and the effects of military conflicts and civil unrest [7]. SCI has been reported in published studies in several Middle Eastern countries with significant proportions of SCI due to road traffic injuries, falls, occupational trauma and conflict-related injuries, indicating the need for region-specific epidemiological evidence, not just data generated in high-income settings. However, there are few long-term epidemiological studies in Iraq, particularly comprehensive studies, due to the country's history of prolonged armed conflict, terrorism, and evolving patterns of injuries that may significantly affect the burden and nature of spinal cord injuries that require rehabilitation [8].

The Iraqi healthcare system has faced decades of unprecedented difficulties due to various factors, including wars, violence, displacement, and changing healthcare needs. These conditions have probably created an SCI epidemiological profile that is different from what is reported in more stable healthcare environments [5-9]. In spite of this unique setting, there are few published epidemiological data on the long-term outcomes of SCI in Iraq and most of the available reports are based on single-center experiences or short observation periods . Thus, there are still many unanswered questions about the temporal evolution of the etiological patterns, neurological presentation, demographic features, and rehabilitation burden [9-11].

Epidemiological studies of SCI should not only focus on the mechanisms of injury, but should also focus on neurological presentation, including the distribution of paraplegia and quadriplegia/tetraplegia, as these patterns of neurological injury have a significant impact on functional dependency, complexity of rehabilitation, long term care needs and utilization of healthcare resources [12]. Combining the epidemiological data with the neurological presentation, therefore, gives a more complete picture of rehabilitation needs than descriptive analyses based on injury mechanisms [13-18].

Rehabilitation center registries are an especially useful source of epidemiological data as they include patients who have survived the acute phase and need specialized long-term rehabilitation. As a result, these databases capture the true burden of rehabilitation services and not just the first occurrence of injury [19]. Longitudinal rehabilitation databases also allow for the analysis of trends in admission rates, demographics, etiology distribution and neurological presentation over long time periods, providing valuable information on changing healthcare needs [20].

In the present study, a large rehabilitation database was used from Ibn Al-Kuaff Spinal Cord Injury Hospital, which is one of the most important specialized rehabilitation hospitals in Iraq, from 2003 to 2026. This database offers a unique opportunity to analyse long-term epidemiological trends in patients with traumatic and non-traumatic spinal cord disorders treated in a specialized rehabilitation centre. The large sample size and long observation period enable a full evaluation of the temporal trends in admission patterns, etiological distribution, demographic characteristics and neurological presentation in the context of the Iraqi healthcare system.

The aim of this study was to describe the demographic, etiological and neurological characteristics of patients admitted to a specialized rehabilitation centre in Iraq with spinal cord injuries and related disorders, to assess the changes in these characteristics over time, and to determine baseline characteristics that would be associated with a more severe neurological presentation on admission. This study aims to fill a critical void in the regional literature and to offer evidence that could help inform rehabilitation service planning, injury prevention strategies, and the future development of comprehensive national spinal cord injury registries that correlate epidemiological characteristics with long-term functional outcomes.

2. Methodology

2.1. Study Design

This retrospective observational analytical study was conducted using the institutional clinical registry of Ibn Al-Kuaff Spinal Cord Injury Hospital in Baghdad, Iraq. The study included patients admitted to or referred for specialized rehabilitation for spinal cord injuries and related spinal cord disorders during the period from 2003 to 2026. The study was designed to describe the epidemiological, etiological, and neurological characteristics of this rehabilitation cohort, evaluate changes in these characteristics over time, and examine baseline factors associated with more severe neurological presentation at admission.

2.2. Study Setting

The study was carried out at the specialized rehabilitation center of Ibn Al-Kuaff Spinal Cord Injury Hospital, affiliated with the Baghdad Al-Russafa Health Directorate, Ministry of Health, Iraq. The hospital receives patients with traumatic and non-traumatic spinal cord diseases from Baghdad and other governorates of Iraq, and provides specialized rehabilitation for patients who have neurological disability as a result of spinal cord diseases.

The rehabilitation setting is methodologically important because it is not the national incidence of spinal cord injury, but the burden of patients who have survived the acute phase and require rehabilitation services. Thus, the results reflect the burden of long-term rehabilitation that was referred to this centre and not the incidence of rehabilitation in Iraq.

2.3. Study Population and Sampling Frame

The study population consisted of all eligible patients recorded in the hospital database during the study period. No sampling procedure was applied. All available records that met the eligibility criteria and contained sufficient core information for analysis were considered for inclusion. After data cleaning and removal of duplicate entries, 4,873 unique patient records were included in the final analytical dataset.

2.4. Eligibility Criteria

Records were eligible for inclusion if they referred to patients admitted or referred to Ibn Al-Kuaff Spinal Cord Injury Hospital during the defined study period and contained sufficient information to identify the admission year or admission date. Records were also required to contain at least one of the core analytical variables, including age, sex, primary etiology, or neurological presentation.

2.5. Data Source and Database Preparation

The data were collected from the hospital electronic registry and transferred to Microsoft Excel for data preparation. The database was checked and converted to a structured analytical file where each row was a patient record and each column was a pre-defined variable. Data Management involved checking patient identifiers, checking the year and date of admission, cleaning categorical labels, fixing obvious formatting errors, and removing duplicate records.

Duplicate records were found mostly based on patient identifiers and repeated demographic or clinical data. If duplicate administrative records were identified that referred to the same patient record, then duplicated information was eliminated and each patient was only included once in the final analytical data set. The final dataset comprised patient identifier, admission year or date, age, sex, primary etiology, broad etiological category, neurological presentation, AIS/ASIA grade when available, and other registry-derived clinical information. Level-of-injury data were initially reviewed during database verification; however, because historical coding of this variable was not sufficiently consistent across the registry, it was not retained in the main descriptive results or inferential analyses.

2.6. Standardization of Clinical Terminology and AIS/ASIA Classification

Because the registry covered more than two decades, variations in clinical documentation and terminology were expected. To improve consistency, all recorded clinical terms were reviewed and harmonized before statistical analysis. Etiological descriptions were mapped into broad analytical

categories, including falls, road traffic injury, violence/war-related injury, non-traumatic/medical causes, other trauma/external force, and other causes when applicable.

Neurological information, including neurological presentation and AIS/ASIA grade, was extracted from the original medical records as documented in the hospital registry by specialized clinical staff. Level-of-injury entries were also reviewed during data verification; however, this variable showed inconsistent historical coding across the long study period and was therefore excluded from the main reported analyses.

This approach was used to address the long duration of the study period and the evolution of ASIA/ISNCSCI-related documentation over time. The purpose of harmonization was not to reinterpret older examinations according to later standards, but to ensure that comparable categories were used consistently in the final analytical dataset. AIS/ASIA grades and neurological levels were therefore analyzed as registry-derived clinical variables, with the limitation that documentation practices may have evolved across the study period.

2.7. Handling of Missing Data

The completeness of the main analytical variables was checked prior to analysis. The amount of missing data for the core variables was extremely low, with missingness estimated to be less than 1% for the principal analytical fields. This small percentage of missing data precluded the use of multiple imputation. The available observations for each variable were used in the analyses and the denominator was reported as the number of valid observations when applicable.

Records were not excluded if the secondary variable was not available, but if it was not available, the record was still available for the primary epidemiological analyses. No attempt was made to infer unavailable clinical information beyond what was documented in the registry and missing or unclear entries were not statistically imputed.

2.8. Study Variables

The age and sex were the primary demographic variables. Age was treated as continuous variable and presented as mean, standard deviation, median and interquartile range. Sex was analyzed as a categorical variable.

The most important etiological variable was the recorded cause of spinal cord injury or related spinal cord disorder. Detailed textual causes were collapsed into larger etiological categories to allow for consistent analysis throughout the long study period. These categories were used to describe, compare over time, and to model multiple variables.

The main neurological variable was presentation at admission. Neurological presentations were broken down into clinically meaningful categories, with special focus on paraplegia and quadriplegia/tetraplegia as these categories represent significant differences in functional dependency and rehabilitation needs. Level-of-injury data were not used as a main analytical variable because retrospective verification showed inconsistent historical coding across the registry. Neurological presentation was therefore retained as the primary neurological classification variable for descriptive and inferential analyses.

2.9. Time Period Classification and Rationale

The primary temporal variable was admission year. For long-term comparison, the study period was divided into four analytical intervals: 2003-2008, 2009-2013, 2014-2018, and 2019-2026. This cluster was chosen for two complementary reasons.

First, from a statistical point of view, the years were grouped together to minimize the random variation between years and to ensure that there were adequate numbers of years in each group for meaningful comparison of etiological and neurological patterns. Second, the chosen intervals are epidemiologically and contextually related to major events in the recent history of Iraq, such as periods of increased violence, shifts in security situation, post-conflict transition and shifts in healthcare delivery and referral systems. These contextual changes were deemed relevant as they could have impacted on the mechanisms of spinal cord injury and the flow of patients through specialized rehabilitation services.

The time periods were therefore used as analytical strata to examine broad temporal shifts, not as direct measures of political or security exposure. The interpretation of period-based findings was limited to changes observed within the rehabilitation registry.

2.10. Statistical Analysis

Data preparation was performed using Microsoft Excel. Statistical analyses were conducted using IBM SPSS Statistics and GraphPad Prism. Categorical variables were summarized as frequencies and percentages. Continuous variables were summarized using mean and standard deviation as well as median and interquartile range when appropriate.

Annual admission counts were analyzed to assess temporal trends. Because the outcome represented count data and overdispersion was assessed, a negative binomial regression model was used rather than a simple Poisson model. Results were expressed as incidence rate ratios (IRRs) with 95% confidence intervals and p values.

Differences in categorical variables, including the distribution of etiological categories across time periods and neurological presentation across cause groups, were assessed using the chi-square test. Differences in age across etiological categories were assessed using the Kruskal-Wallis test because age distribution across groups was not assumed to be normally distributed.

A multivariable binary logistic regression model was used to identify baseline factors associated with quadriplegia/tetraplegia compared with paraplegia. The dependent variable was neurological presentation, with quadriplegia/tetraplegia as the outcome category and paraplegia as the reference category. Predictor variables included age, sex, broad etiological category, and time period. Results were reported as adjusted odds ratios (ORs) with 95% confidence intervals and p values.

Model performance was assessed using available model indices, including pseudo-R2 and area under the receiver operating characteristic curve (AUC), where applicable. A sensitivity analysis was performed by restricting the regression model to the main etiological groups with more stable classification. A two-sided p value of less than 0.05 was considered statistically significant.

2.11. Ethical Considerations

The study protocol was reviewed and approved by the Research Committee of the National Centre for Training and Human Development, Ministry of Health, Iraq (Decision No. 47/2026; dated 12 February 2026). Institutional permission was obtained from Ibn Al-Kuaff Spinal Cord Injury Hospital before analysis of the registry data. Because the study was retrospective and based on de-identified registry information, individual informed consent was waived according to the applicable institutional and ethical procedures. Patient confidentiality was maintained throughout data extraction, cleaning, and analysis.

2.12. Methodological Scope and Limitations

This study aimed to describe the burden of rehabilitation of spinal cord injuries and related disorders in a specialized Iraqi rehabilitation center. It was not designed to measure national incidence, effectiveness of treatment or long term functional outcomes. Variations in documentation practices may have occurred over the long time period of registry accumulation and the retrospective design, particularly for detailed neurological and functional variables.

The large number of patients, long follow-up period and the use of a specialized rehabilitation registry provide an important basis for evaluating the temporal changes in the demographic, etiological and neurological characteristics of patients who access spinal cord injury rehabilitation services in Iraq.

3. Results

A total of 4,873 records were included in the final analysis, representing 4,873 unique patient IDs. Data completeness was high for the main analytical variables, with available values for admission date in 97.0%, age in 99.4%, cause in 99.8%, and neurological presentation in 99.6% of records. Sex was available for all patients. The cohort was predominantly male (4,487; 92.1%) with a smaller proportion of females (386; 7.9%). The median age was 32.0 years (IQR 23.0–46.0), while the mean age was 34.93 ± 15.64 years (Table 1,2).

Table 1. High-level analytical highlights

High level finding	Result
Dataset size	4,873 records with 4,873 unique IDs
Sex distribution n, %	4,487 male (92.1%) and 386 female (7.9%)
Central age tendency	Median age 32.0 years (IQR 23.0-46.0); mean 34.93 ± 15.64
Most common broad cause n, %	Violence/war-related (n=1,588, 32.6%)
Most common neurology pattern n, %	Paraplegia (n=4,143, 85.0%)
Annual trend model	Negative binomial IRR per year 0.947 (95% CI 0.905-0.991; p=0.0192)
Cause distribution changes over time	Chi-square p=1.592e-93
Age differs across main causes	Kruskal-Wallis p=0.0002
Neurology pattern differs by cause	Chi-square p=0.0351
Main regression	Older age was associated with higher odds of quadriplegia/tetraplegia: OR 1.007 per year (95% CI 1.002-1.012; p=0.0064)

Table 2. Overall summary statistics for the study cohort

Metric	Value
Total records	4,873
Unique Patient_IDs	4,873
Date completeness (%)	97
Age completeness (%)	99.4
Sex completeness (%)	100
Cause completeness (%)	99.8
Neurology completeness (%)	99.6
Mean age	34.93
SD age	15.64
Median age	32
Age Q1	23
Age Q3	46
Male n	4,487
Male %	92.1
Female n	386
Female %	7.9

With respect to etiology, the most common broad cause category was violence/war-related injury, 1,588 cases (32.6%), followed by non-traumatic/medical causes, falls, and road traffic injury. Neurologically, paraplegia was the dominant presentation, accounting for 4,143 cases (85.0%), whereas quadriplegia/tetraplegia and others were observed in a substantially smaller subset (Table 3).

Table 3. Distribution of key analytical variables in the study cohort

Variable	Category	n	%
Sex	Male	4487	92.1
	Female	386	7.9
Cause (broad)	Violence/war-related	1588	32.6
	Non-traumatic/medical	1068	21.9
	Falls	1046	21.5
	Road traffic injury	980	20.1
	Other trauma/external force	173	3.6
	Missing	11	0.2
	Other	7	0.1
Neurological presentation	Paraplegia	4143	85
	Quadriplegia/Tetraplegia	692	14.2
	Hemiplegia/Other	19	0.4
	Missing	19	0.4
AIS/ASIA grade	A	2318	47.6
	B	1548	31.8
	C	611	12.5
	D	396	8.1

Note: Level-of-injury and trauma-type variables were rechecked during database verification. Because these variables showed inconsistent historical coding across the registry and were not used in the primary inferential analyses, they were removed from the main descriptive table to avoid clinically misleading interpretation.

Annual admissions demonstrated a significant downward temporal trend across the study period. In a negative binomial trend model, each additional year was associated with a reduction in admissions rate of about 5.3% (IRR 0.947, 95% CI 0.905–0.991; p = 0.019), indicating a significant long-term decline despite year-to-year variation (Figure 1).

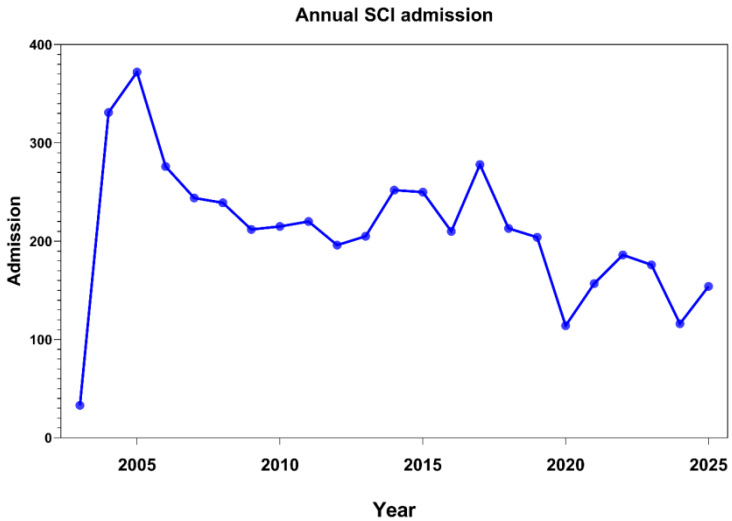

Figure 1. Annual admissions across the study period

During database verification, neurological presentation was retained as the primary neurological classification variable because it was consistently documented across the registry and formed the basis of the main analysis. In contrast, level-of-injury coding showed inconsistency across historical records and could not be reliably harmonized across the entire study period. Therefore, level-of-injury data were removed from the main descriptive table and were not included in inferential analyses. This conservative approach was adopted to avoid clinically misleading interpretation.

The epidemiological composition of admissions showed a marked temporal shift after the study interval was divided into four periods. (2003–2008, 2009–2013, 2014–2018, and 2019–2026). The distribution of broad cause groups changed significantly per the time (X^2 = 483.68, df = 15, p <0.001) (Tables 4,5; Figure 2,3).

Table 4. Negative binomial model of annual temporal trend

Metric	Value
IRR per additional year	0.947
95% CI low	0.905
95% CI high	0.991
p-value	0.019
Dispersion alpha	0.540

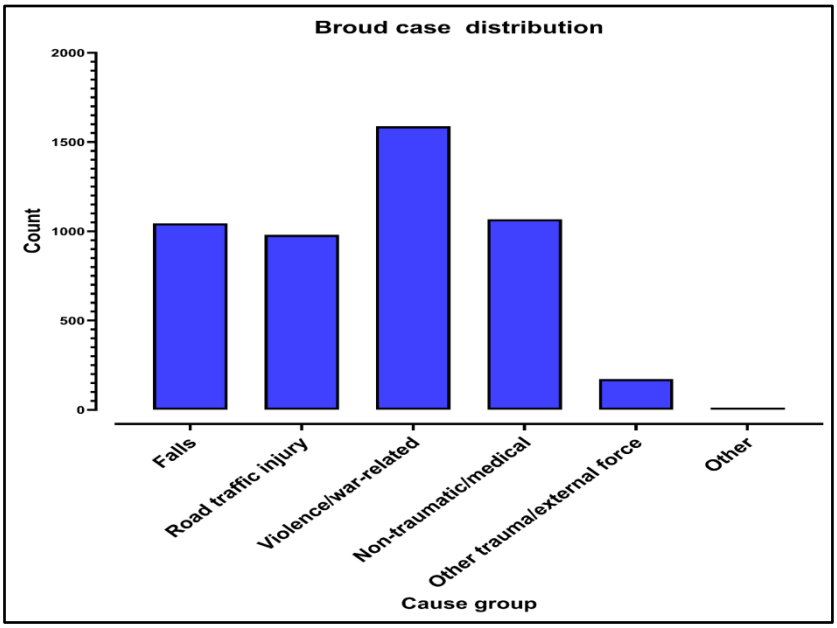

Figure 2. Overall, of the distribution of broad cause categories.

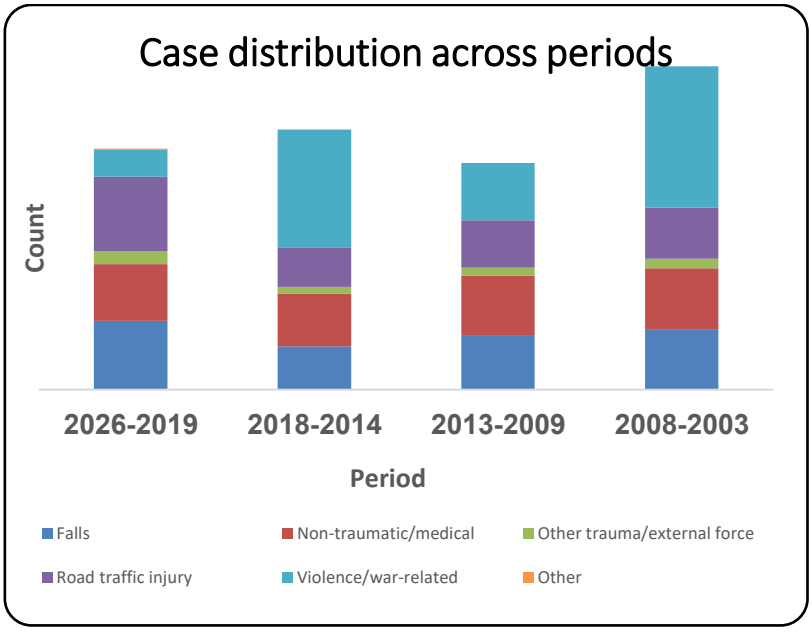

Figure 3. Broad cause distribution across time period

Table 5. Distribution of broad cause per the time period (counts)

Cause Broad	2003-2008	2009-2013	2014-2018	2019-2026
Falls	278	249	200	319
Non-traumatic/medical	283	278	245	262
Other	0	0	1	6
Other trauma/external force	45	37	31	60
Road traffic injury	236	220	180	344
Violence/war-related	653	264	547	124

Table 6. Broad cause distribution according to time period (percentages for columns)

Cause Broad	2003-2008	2009-2013	2014-2018	2019-2026
Falls	18.6	23.8	16.6	28.6
Non-traumatic/medical	18.9	26.5	20.3	23.5
Other	0	0	0.1	0.5
Other trauma/external force	3	3.5	2.6	5.4
Road traffic injury	15.8	21	15	30.9
Violence/war-related	43.7	25.2	45.4	11.1

Table 7. Global test for change in cause distribution across periods

Test	Statistic	DF	P value
Chi-square: cause distribution across periods	484	15	0

Age of the patients were significantly differed through the major categories cause, $p < 0.005$ (Kruskal–Wallis). Non-traumatic/medical causes patients had highest age profile (mean 36.6 ± 16.00 years, median 34.5 years), on average road traffic injury, and violence/war-related causes patients ware younger (Table 6,7; Figure 4)

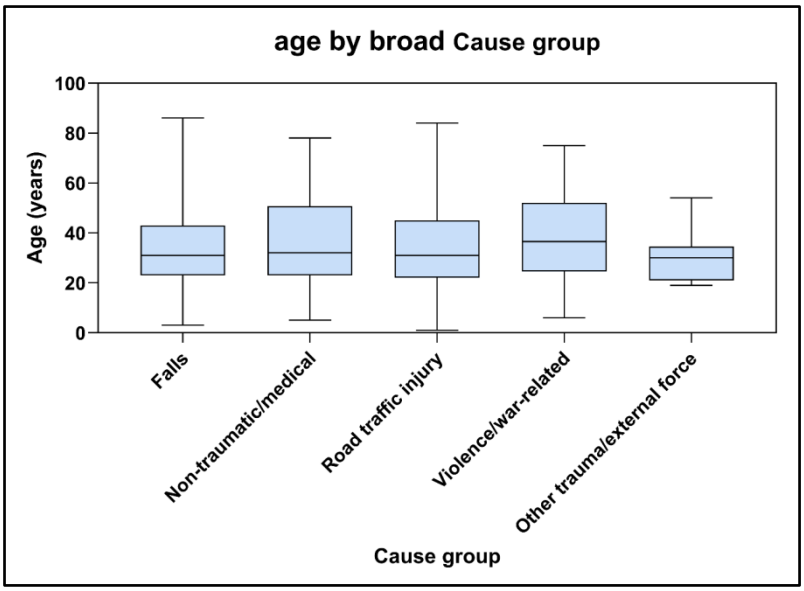

Figure 4. Age by the broad cause group

Table 8. Age distribution according to broad cause group

Cause Broad	n	mean	sd	median	q1	q3
Falls	1037	33.65	14.43	31	23	43
Non-traumatic/medical	1068	36.59	16.3	34.5	24	50
Other	7	40.14	19.89	29	25.5	55.5
Other trauma/external force	172	32.98	15.29	30	21	45
Road traffic injury	969	34.68	15.82	32	22	45
Violence/war-related	1580	34.99	15.81	32	23	46

The finding showed that paraplegia remained the predominant neurological pattern was significantly higher among all major causes, while there are proportion of quadriplegia/tetraplegia varied between groups (Tables 8, 9,10; Figure 5).

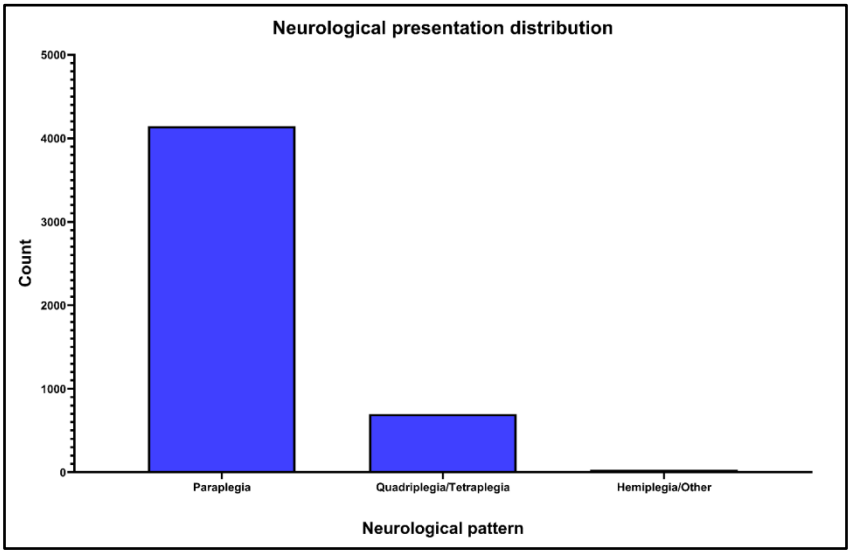

Figure 5. The distribution of neurological presentation

Table 9. Neurological presentation according to broad cause group (counts)

Cause Broad	Hemiplegia/Other	Paraplegia	Quadriplegia/Tetraplegia
Falls	10	890	137
Non-traumatic/medical	5	892	170
Other	0	5	3
Other trauma/external force	0	154	19
Road traffic injury	1	839	136
Violence/war-related	3	1353	227

Table 10. Neurological presentation (%) according to broad cause group

Cause Broad	Hemiplegia/Other(%)	Paraplegia(%)	Quadriplegia/Tetraplegia(%)
Falls	1	85.8	13.2
Non-traumatic/medical	0.5	83.6	15.9
Other	0	71.4	28.6
Other trauma/external force	0	89	11
Road traffic injury	0.1	86	13.9
Violence/war-related	0.2	85.5	14.3

A multivariable logistic regression model was created to clarified independent predictors of quadriplegia/tetraplegia with paraplegia. There is no significant difference was found with respect to sex, broad cause group, and time period, while age was the only statistically significant independent predictor. Each one-year increase in age was associated with a 0.7% increase in the odds of quadriplegia/tetraplegia (OR 1.007, 95% CI 1.002–1.012; p = 0.006). Sex, cause categories, and time periods were not show statistically significant in the adjusted model (Table 11,12).

Table 11. Multivariable logistic regression for quadriplegia/tetraplegia versus paraplegia

Variable	OR	CI low	CI high	P value
Intercept	0.1192	0.08	0.1776	0
Male sex (vs Female)	0.9895	0.7358	1.3307	0.944
Road traffic injury (vs Falls)	1.0466	0.8102	1.3518	0.727
Violence/war-related (vs Falls)	1.0931	0.8636	1.3835	0.45
Non-traumatic/medical (vs Falls)	1.205	0.9435	1.5391	0.135
Other trauma/external force (vs Falls)	0.8008	0.4808	1.3336	0.393
Other (vs Falls)	2.3942	0.4566	12.5553	0.302
2009–2013 (vs 2003–2008)	1.0392	0.8261	1.3071	0.743
2014–2018 (vs 2003–2008)	1.0092	0.8097	1.258	0.935
2019–2026 (vs 2003–2008)	1.0706	0.8499	1.3486	0.562
Age (per year)	1.0071	1.002	1.0122	0.006

Table 12. Sensitivity analysis: restricted multivariable logistic regression

Variable	OR	CI low	CI high	P value
Intercept	0.115	0.076	0.172	0
Male sex (vs Female)	0.998	0.738	1.350	0.993
Road traffic injury (vs Falls)	1.045	0.809	1.351	0.731
Violence/war-related (vs Falls)	1.087	0.858	1.376	0.488
Non-traumatic/medical (vs Falls)	1.202	0.941	1.535	0.140
Other trauma/external force (vs Falls)	1	1	1	0.416
Other (vs Falls)	1	1	1	0.402
2009–2013 (vs 2003–2008)	1.030	0.815	1.301	0.801
2014–2018 (vs 2003–2008)	1.046	0.837	1.306	0.690
2019–2026 (vs 2003–2008)	1.076	0.850	1.362	0.538
Age (per year)	1.007	1.002	1.012	0.003

Overall, this cohort study's statistical analysis shows a clear predominance of paraplegic presentations, a concentration in young and middle adulthood, and a strong male predominance.

In the aggregate dataset, mechanisms related to violence and war constituted the largest etiological category; however, the composition of causes changed dramatically over time.

In the adjusted analysis, the only independent predictor of quadriplegia/tetraplegia was age. However, the low pseudo-R^2 and AUC values show that only a small percentage of neurological presentation severity can be explained by the current baseline variables, indicating that lesion-level, ASIA completeness, functional, and follow-up variables would be beneficial for future models.

4. Discussion

This study provides a long-term rehabilitation-based overview of spinal cord injuries and related spinal cord disorders admitted to a major specialized center in Iraq over more than two decades. The principal findings were a marked male predominance, concentration of cases among young and middle-aged adults, a substantial contribution of violence- and war-related injuries, predominance of paraplegic neurological presentation, significant temporal changes in etiological distribution, and a declining annual admission trend across the study period. These findings should be interpreted within the specific clinical and historical context of Iraq, where patterns of trauma, conflict exposure, referral pathways, and rehabilitation service availability have changed considerably over time. International evidence confirms that the epidemiology of spinal cord injury varies substantially across countries, health systems, and social contexts; therefore, local long-term data are essential for interpreting the rehabilitation burden in settings affected by conflict and health-system transition [1-4].

The high proportion of males in this cohort is typical of the epidemiology of spinal cord injury, in which males predominate in most international and regional series [3,7,8]. This is probably due to higher exposure of males to high risk situations such as road traffic, manual work, occupational risk and violence-related trauma. This is of social significance in the Iraqi context as many of the affected people are in economically productive age groups and may have significant family and occupational responsibilities. Thus, the impact of spinal cord injury in this context is not just neurological, but also economic, social, and psychological [10]. These consequences are similar to those reported in published literature, which indicate that the health-related quality of life, economic and caregiver burden of spinal cord injury are significant [12-14].

The age distribution further emphasizes the public health importance of spinal cord injury in Iraq. The median age of 32 years suggests that the majority of patients were young or middle-aged adults. This is in contrast to many chronic neurological conditions that are more likely to affect older people, and is a reflection of the long-term disability that follows a spinal cord injury. Young patients may suffer from mobility limitations, bladder and bowel dysfunction, risk of pressure injuries, pain, psychosocial challenges, and decreased participation in work and community life for decades.

However, in rehabilitation planning, this implies that services for spinal cord injury should not only be offered in acute inpatient rehabilitation, but also in long-term follow-up, community reintegration, vocational rehabilitation and prevention of secondary complications [11,12].

One of the most important findings of this study is the decline in annual admissions over time. This pattern should not be interpreted automatically as evidence of a true reduction in the national incidence of spinal cord injury. Several explanations are possible. First, changes in the intensity and nature of armed conflict may have influenced the number of severe violence-related injuries reaching the center [20]. Second, changes in acute trauma care, neurosurgical services, and referral pathways may have altered the flow of patients to specialized rehabilitation. Third, some patients may have been managed in other hospitals, governorate-level facilities, private rehabilitation services, or outside formal rehabilitation pathways. Fourth, changes in institutional documentation or admission policies over time may have affected recorded admissions [21]. Therefore, the observed decline should be interpreted as a decrease in admissions to this specialized rehabilitation hospital rather than definitive evidence of reduced national incidence [20,21].

The marked difference in etiological distribution over time indicates that the burden of spinal cord injuries presented to specialized rehabilitation services was not constant. This time change could be due to changes in security, trauma exposure, access to health care, referral systems, or institutional documentation [3-6]. In particular, there may have been a relative shift to road traffic injuries, falls or non-traumatic causes of spinal injuries in later periods, as the pattern of national injury burden changed, due to increased violence during these periods. This study is retrospective and rehabilitation-based, and cannot identify whether the changes are real national incidence changes or changes in referral and admission patterns. However, the observed changes are epidemiologically significant as they indicate that rehabilitation services need to evolve with changing injury mechanisms and not be based on a historical trend [1,4,8].

One of the most significant results of the study is the decrease in annual admissions, which needs to be interpreted carefully. This decrease should not be interpreted as a real decrease in the national rate of spinal cord injury. There are a number of possibilities. Second, the intensity and type of armed conflict could have affected the number of severe violence-related traumas reaching the center during the study period. Third, the intensity and type of armed conflict may have affected the number of severe violence-related traumas reaching the center during the study period. Second, changes or improvements in the distribution of referrals and in the care of acute trauma and neurosurgical services in Iraq could have influenced the pathway to specialized rehabilitation. Third, some patients may have been treated in other hospitals, governorate level hospitals, private rehabilitation services, or in rehabilitation pathways outside of the formal system. Fourth, the number of admissions may have been affected by long-term changes in documentation and admission policies in the registers. Thus, the downward trend should be viewed as a decrease in admissions to this specialized rehabilitation facility, not as a decrease in the incidence of the disease in the country.

The majority of patients in the cohort had lower-limb motor impairment, required mobility training, were using a wheelchair, needed to prevent pressure injuries, and needed bladder and bowel care, among other things, which is why paraplegia was the predominant condition [11-18]. While quadriplegia/tetraplegia is typically more dependent and more complex to care for, there is a significant rehabilitation burden associated with a large paraplegic population due to the requirement for long-term physical rehabilitation, assistive devices, home modification, vocational support and lifelong prevention of complications [4-6,11,12]. Even in a health care system where there is little specialized rehabilitation resources, case profiles that are predominantly paraplegia can create significant service needs [23].

The relationship between etiology and neurological presentation was statistically significant in unadjusted comparisons, although the differences between cause groups were modest. This suggests that injury mechanism may influence neurological pattern at a descriptive level, but broad etiological categories alone are insufficient to explain neurological severity. Clinically, neurological presentation is more directly determined by anatomical level of injury, extent of cord damage, completeness of injury, associated vertebral instability, time to acute management, and early complications. Because several of these variables were not available with sufficient consistency

across the entire registry, the ability to explain neurological severity using the available baseline variables was necessarily limited [24].

The multivariable logistic regression showed that age was the only independent factor associated with quadriplegia/tetraplegia. However, the very low pseudo-R2 and the AUC close to chance level indicate that the model has limited explanatory value and no meaningful predictive utility. Therefore, this model should be interpreted only as an exploratory analysis of baseline associations, not as a predictive tool for neurological outcome. The weak performance of the model most likely reflects the absence of more clinically proximal predictors, such as exact neurological level, injury completeness, lesion morphology, acute imaging findings, associated injuries, timing of surgical or medical intervention, and early complications. Accordingly, the main strength of this study lies in its large-scale descriptive, comparative, and temporal analysis rather than in the predictive capacity of the regression model [20,24].

The finding that age remained associated with quadriplegia/tetraplegia may reflect increased vulnerability to cervical or more severe neurological injury among older patients, as well as the contribution of degenerative, non-traumatic, or lower-energy mechanisms that may disproportionately affect the cervical spine. Previous research has shown that older age at the time of spinal cord injury may influence rehabilitation outcomes, care needs, and complication risk [10,13]. However, the effect size in the present study was small and should not be overinterpreted. More detailed anatomical and functional data would be required to determine whether age independently influences neurological severity or whether it acts through unmeasured variables such as mechanism of injury, pre-existing spinal degeneration, comorbidity, and delayed access to acute care [10-14].

The effect on the Iraqi health care system is huge. A rehabilitation center that has been treating thousands of spinal cord injury patients for 20 years requires not only inpatient beds, but coordinated pathways for long-term care as well. These should encompass a standardised referral process from acute hospitals, access to urological and pressure injury management, psychological support, assistive technology, social reintegration programmes and post-discharge follow up systems [18-21]. Violence and war-related injuries are also common, further highlighting the need for trauma-informed rehabilitation services, including psychological assessment and family-based rehabilitation methods. These service needs are supported by evidence that SCI is a long-term burden that is complex and involves quality of life, cost, psychosocial adjustment and caregiver needs [12,14].

The study also highlights the need to set up a national spinal cord injury registry in Iraq. Standardised registry would allow for standardised documentation of neurological level, AIS/ASIA grade, injury completeness, mechanism of injury, complications, rehabilitation duration, functional outcome, mortality and quality of life. This would improve the ability to monitor trends, to determine the need for services, to compare Iraqi data with international registries and to develop prevention policies according to the local burden. In the absence of national data, rehabilitation planning will remain dependent on institutional databases which are useful but have limited capacity to estimate national incidence or long-term outcomes [1,2,8].

There are a number of strengths in this study. It has a large sample size, long observation period, and data from a large specialized rehabilitation hospital in Iraq. It also incorporates demographic, etiological, neurological and temporal analyses, giving a comprehensive overview of the rehabilitation burden over time. The study is useful contribution to the scarce literature available in the region on spinal cord injury, especially in the context of a conflict-affected country and transition of health services.

There are a number of limitations to be considered. First, the research was retrospective and single-center, thus the results are based on admissions to a specialized rehabilitation hospital and not national incidence. Second, the registry was not initially created as a prospective research database, but rather as a clinical and administrative tool, which restricted the availability and consistency of certain variables throughout the entire study period. Third, not all patients had detailed information on the exact neurological level, injury completeness, acute management, comorbidities, complications, rehabilitation duration, and long-term functional outcomes. Fourth, the shift in referral patterns, documentation and access to healthcare over time might have contributed to the trend in admissions. Lastly, the regression model was weak in its explanatory power and cannot be used to predict.

Overall, spinal cord injuries and associated disorders admitted to Ibn Al-Kuaff Spinal Cord Injury Hospital constitute a significant, chronic, and dynamic rehabilitation burden in Iraq. The results indicate a male and working-age population, a large role of violence- and war-related injuries, a preponderance of paraplegia, and a substantial change in the admission and etiological trends over time. The falling admission pattern is probably the result of a combination of shifting conflict exposure, referral pathways, healthcare organization, and documentation practices and not merely a decrease in the number of cases of disease. These results justify the necessity of enhanced rehabilitation facilities, the development of national registries, and long-term research with outcomes to inform prevention and rehabilitation planning in Iraq.

5. Conclusion

The present study reveals that spinal cord injuries and associated spinal cord disorders hospitalized in Ibn Al-Kuaff Spinal Cord Injury Hospital in Baghdad constitute a significant and time-varying rehabilitation burden in Iraq. The cohort was also distinguished by significant male dominance and concentration in young and middle-aged adults. Paraplegia was the most common neurological manifestation with a smaller percentage of cases being quadriplegia/tetraplegia.

The most frequent etiological group in the total sample was violence- and war-related injuries, which is typical of the Iraqi situation and differentiates this cohort of the population with numerous reports in more stable environments, where road traffic injuries and falls are common. The researchers also demonstrated that there were considerable temporal variations in the number of admissions and etiological distribution of spinal cord injury and related disorders, which means that the burden of this disease is not fixed and can be affected by the alterations in the security conditions, healthcare organization, referral pathways, and documentation practices.

Age was the only variable that was independently related to higher odds of quadriplegia/tetraplegia at admission in the multivariable analysis, and sex, broad etiological category, and time period were not independently related to neurological presentation. Nonetheless, the poor explanatory power of the model suggests that the neurological presentation cannot be sufficiently explained by the baseline demographic and etiological variables. Stronger explanatory and prognostic models require more detailed clinical variables, such as precise neurological level, injury completeness, AIS/ASIA classification, complications, rehabilitation course, and long-term functional outcomes.

These findings support the need for a systematic national registry for spinal cord injuries and related disorders in Iraq, linking epidemiological, clinical, neurological, and rehabilitation data with long-term functional outcomes. This type of data is necessary to enhance rehabilitation planning, reinforce prevention strategies, and create services that consider the unique patterns of injuries and healthcare requirements of the Iraqi population.

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Conflict of interest

The author declare that they have no conflict of interest.

Ethics approval

The study protocol was reviewed and approved by the Research Committee of the National Centre for Training and Human Development, Ministry of Health, Iraq (Decision No. 47/2026; Date: 12/2/2026). Institutional permission was also obtained from Ibn Al-Kuaff Spinal Cord Injury Hospital before data collection. Because this was a retrospective study based on registry data, all data were handled confidentially and analyzed in a de-identified form. The requirement for individual informed consent was waived due to the retrospective nature of the study and the use of anonymized data.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available because they contain clinical information derived from patient records and institutional rehabilitation registry data. De-identified data may be made available from the corresponding author upon reasonable request and subject to approval by the relevant institutional and ethical authorities.

Authors Contributions

Mustafa Alburhan contributed to study conception and design, data analysis, interpretation of findings, and manuscript drafting. **George Albarwary** contributed to data collection, clinical input, and manuscript revision. **Diaa Kazim Al-Quraishi** contributed to data verification, methodological support, and critical review of the manuscript. **Yaser Mustafa** supervised the study, contributed to interpretation of results, and revised the manuscript critically. All authors read and approved the final manuscript.

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الأنماط البيوكيميائية والوبائية والعصبية لإصابات الحبل الشوكي في العراق: دراسة استرجاعية مستندة إلى المستشفيات على مدى 23 عامًا لإثراء تخطيط الصحة العامة وإعادة التأهيل

الملخص

الخلفية: تُعد إصابات واضطرابات الحبل الشوكي حالات عصبية تُسبب عبئًا صحيًا ووظيفيًا طويل الأمد، إذ تُؤدي إلى عجز حركي وحسي طويل الأمد، وتراجع في الاستقلالية وجودة الحياة، وحاجة مستمرة إلى خدمات طبية وتأهيلية متخصصة. تُعدّ دراسة هذه الحالات في السياق العراقي ذات أهمية بالغة، نظرًا للتداخل بين الإصابات الرضية التقليدية والإصابات المرتبطة بالعنف والحرب والأسباب الطبية غير الرضية. الهدف: هدفت هذه الدراسة إلى توصيف الخصائص الديموغرافية والسببية والعصبية لحالات إصابات واضطرابات الحبل الشوكي المُحالة إلى مركز تأهيل متخصص في العراق، وتحليل التغيرات في أنماطها بمرور الوقت، وتحديد العوامل المرتبطة بأشدّ الأنماط العصبية عند القبول. المنهجية: أُجريت دراسة رصدية استرجاعية في مستشفى ابن الكوف لإصابات الحبل الشوكي في بغداد، استنادًا إلى قاعدة بيانات طويلة الأمد تغطي الفترة من عام 2003 وحتى نهاية فترة الدراسة. شملت الدراسة 4873 سجلًا فريدًا، وخضعت البيانات لعملية تنقيح وتوحيد المصطلحات السريرية والسببية. تم تحليل المتغيرات الديموغرافية والسببية والعصبية، وفُحصت الاتجاهات الزمنية في حالات الدخول السنوية باستخدام تحليل الانحدار ذي الحدين السالب، بينما قُيّمت العوامل المرتبطة بالشلل الرباعي باستخدام تحليل الانحدار اللوجستي الثنائي متعدد المتغيرات. النتائج: أظهرت النتائج غلبة واضحة للذكور بنسبة 92.1%، بمتوسط عمر 32 عامًا. كانت الإصابات المرتبطة بالعنف والحرب السبب الأكثر شيوعًا بنسبة 32.6%، تليها الأسباب غير الرضحية/الطبية، ثم السقوط وحوادث المرور. كان الشلل النصفي هو النوع الأكثر شيوعًا لإصابات الحبل الشوكي (85.0%)، مقارنةً بنسبة 14.2% للشلل الرباعي. كما أظهر التحليل الزمني انخفاضًا ملحوظًا في حالات الدخول السنوية، مع تحول واضح في توزيع الأسباب عبر الفترات الزمنية. في تحليل الانحدار اللوجستي متعدد المتغيرات، ارتبط التقدم في السن بشكل مستقل بزيادة احتمالية الإصابة بالشلل الرباعي (نسبة الأرجحية 1.007، فاصل الثقة 95% 1.002-1.012؛ قيمة(p = 0.006 ، بينما لم يرتبط الجنس، أو الفئة السببية العامة، أو فترة الدراسة بشكل مستقل بالأعراض العصبية. الخلاصة: تكشف الدراسة عن عبء تأهيلي كبير ومتغير بمرور الوقت لإصابات واضطرابات الحبل الشوكي في العراق، يتميز بغلبة الذكور، وتركز الإصابات بين البالغين في سن العمل، وبروز الإصابات المرتبطة بالعنف والحرب. تدعم هذه النتائج الحاجة إلى سجلات وطنية أكثر تفصيلاً تربط الخصائص الوبائية بالنتائج الوظيفية طويلة الأجل.

الكلمات المفتاحية: إصابة الحبل الشوكي؛ التأهيل؛ علم الأوبئة؛ دراسة استرجاعية؛ الأعراض العصبية