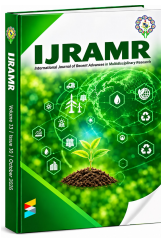
ISSN : 2350-0743

International Journal of Recent Advances in Multidisciplinary Research

Vol. 13, Issue 10, pp.12938-12944, October, 2026
https://doi.org/10.64485/ijramr.6769.10.2026



RESEARCH ARTICLE

INJURY MECHANISMS AND SEVERITY OF TRAUMATIC SPINAL CORD INJURY: ROAD-TRAFFIC CRASHES DETERMINE LESION FREQUENCY RATHER THAN PROGNOSIS. A COHORT STUDY OF 366 PATIENTS IN CÔTE D'IVOIRE

Yao Bernard Fionko[1,2,*], Diaby Raissa Abibatou Yasmina[3], Serge Konan Yao[1,2], Kouassi Jean-Jacques[1], Djoko Traoré[1], Adama Simaga[1] and Aderehime Haidara[1,2]

[1]Department of Neurosurgery, Bouaké University Hospital Center, Bouaké, Côte d'Ivoire
[2]UFR of Medical Sciences, Alassane Ouattara University of Bouaké, Bouaké, Côte d'Ivoire
[3]Department of Neurosurgery, Yopougon University Hospital Center, Abidjan, Côte d'Ivoire

ARTICLE INFO

Article History:
Received 18th July, 2026
Received in revised form
25th August, 2026
Accepted 24th September, 2026
Published online 30th October, 2026

Keywords:
Traumatic Spinal Cord Injury, Injury Mechanism, Road-Traffic Crash, ASIA Grade, In-Hospital Mortality, West Africa.

Corresponding author:
Faozo Stéphane Landry Teti

ABSTRACT

Background: Injury mechanism is often regarded as a marker of severity in traumatic spinal cord injury (TSCI). We assessed whether it is an independent determinant of neurological severity, polytrauma and in-hospital mortality. **Methods:** Single-centre observational cohort of 366 patients with confirmed TSCI (2017–2021 and 2025–2026) at the Bouaké University Hospital Center, reported according to STROBE. Mechanisms were compared with chi-square and rank tests; the independent association with mortality was estimated with adjusted Firth penalised regression, with internal validation by bootstrap. **Results:** Median age was 35 years and 80.9% were men. Road-traffic crashes predominated (62.6%); complete injury (ASIA A) affected 40.2% of patients and in-hospital mortality was 17.5%. Age differed by mechanism ($p < 0.001$), but mechanism was associated with neither neurological severity, nor lesion level, nor polytrauma, nor recovery (all $p \geq 0.13$). After adjustment, road-traffic crashes were not associated with mortality (OR 0.92; 95% CI 0.46–1.84). The only independent determinants of death were ASIA grade A (OR 11.21; 95% CI 5.54–22.67) and cervical involvement (OR 2.08). **Conclusion:** Mechanism accounted for the epidemiological distribution of TSCI without independent prognostic value; initial neurological severity remained the main factor associated with death. Prevention should target road-traffic crashes, and clinical orientation should rely on neurological assessment.

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Citation: ***Yao Bernard Fionko, Diaby Raissa Abibatou Yasmina, Serge Konan Yao, Kouassi Jean-Jacques, Djoko Traoré, Adama Simaga and Aderehime Haidara. 2026.*** *"*Injury mechanisms and severity of traumatic spinal cord injury: road-traffic crashes determine lesion frequency rather than prognosis. A cohort study of 366 patients in Côte d'Ivoire*", International Journal of Recent Advances in Multidisciplinary Research, 13,(10), 12938-12944.*

INTRODUCTION

Traumatic spinal cord injuries (TSCI) are among the most severe causes of acquired neurological disability in young adults and represent a considerable health, social and economic burden, owing to their early mortality, their often irreversible sequelae and the high cost of specialised care and rehabilitation (1). According to Global Burden of Disease estimates, their incidence is rising in low- and middle-income countries, driven by rapid urbanisation, increasing motorisation and insufficiently developed road-safety systems (1) (2). In sub-Saharan Africa, TSCI mainly affect young adult men of working age, and road-traffic crashes (RTC) are now the leading injury mechanism, ahead of falls and assaults (3)-(5). This trend reflects the growth of the car and motorcycle fleet, inadequate road infrastructure and poor compliance with safety rules, compounded by the limits of prehospital emergency systems, prolonged delays to care, non-medicalised transport and still restricted access to specialised care (4) (6).

Injury mechanism occupies a central place in epidemiological studies: it guides prevention and is often regarded, implicitly, as an indicator of severity. So-called "high-energy" trauma is thus frequently assumed to cause more severe lesions, more cervical involvement and higher mortality. This relationship nevertheless remains debated, since neurological severity depends on a complex interaction between the energy actually transmitted to the spine, biomechanical stresses, osteoligamentous lesions and secondary mechanisms of spinal cord injury. Mechanism might therefore reflect the exposure of a population rather than an individual prognostic determinant. Most African studies describe the distribution of mechanisms without distinguishing this epidemiological role from a possible independent prognostic value, and few have used a multivariable approach assessing mechanism, initial neurological severity, lesion level and polytrauma simultaneously. We tested the hypothesis that injury mechanism mainly determines the frequency of TSCI without being, after adjustment for initial neurological severity and the

main prognostic factors, an independent determinant of in-hospital mortality. The objectives were to describe the distribution of mechanisms and the associated sociodemographic profile, to analyse the association between mechanism and initial severity, and to determine whether mechanism retained independent prognostic value for in-hospital mortality.

Patients and Methods

Study design and population: This was a single-centre observational cohort study conducted in the neurosurgery department of the Bouaké University Hospital Center, a referral centre in Côte d'Ivoire, reported according to the STROBE recommendations (7). The cohort combines a retrospective phase covering patients hospitalised from 1 January 2017 to 31 December 2021 and a prospective phase conducted from 1 January 2025 to 30 June 2026; the years 2022 to 2024 are not represented in the audited database available for this study, as standardised data collection resumed in January 2025. Patients with a TSCI confirmed clinically and on imaging, with a usable record allowing ASIA classification, were included; incomplete records, duplicates and non-traumatic conditions were excluded. Three hundred and eighty-three records were assessed for eligibility, 17 were excluded (9 non-traumatic conditions, 5 duplicates, 3 inconclusive records) and 366 patients formed the analysis population (Figure 1). As a tertiary referral centre, the institution preferentially receives the most severe forms: minor trauma, prehospital deaths and patients managed in peripheral facilities are not represented.

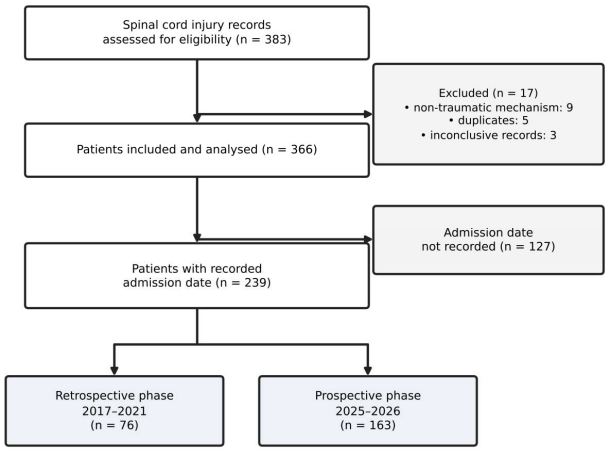


Figure 1. Flow diagram of participant selection (STROBE). Three hundred and eighty-three records assessed for eligibility, 17 exclusions and 366 patients analysed. The admission date is not recorded for 127 patients, which restricts the comparison of the two data-collection phases to 239 patients

Diagnostic criteria, neurological classification, imaging protocols and data-collection procedures remained unchanged between the two periods. The comparison of the main characteristics between the dated phases (Table 3) showed no significant difference for age, sex, ASIA severity, cervical level or mortality; only the proportion of road-traffic crashes was higher in the recent phase (68.7% versus 47.4%; $p = 0.003$). This comparison, however, covers only the 239 patients whose admission date is recorded. Among the 127 patients without a date, in-hospital mortality reaches 31.5% versus 10.0% among dated patients ($p < 0.001$), whereas initial neurological severity is comparable (35.4% versus 42.7% of ASIA A grades): the absence of a date is therefore not independent of the primary outcome and probably reflects the lower completeness of the oldest records and of stays cut short by early death. The stability of the distribution of neurological severity between the two dated phases justifies their joint analysis, but this justification cannot be extended to undated records.

Variables and definitions: Injury mechanism refers to the circumstances of the trauma (road-traffic crash, fall, assault, work-related accident, sports accident or other), without prejudging the energy actually transmitted to the spine: two road-traffic crashes may transmit very different amounts of energy depending on speed, type of vehicle, use of safety devices or direction of impact. Mechanism must therefore be considered an indicator of circumstances, not a direct measure of injury violence. The notion of "high energy" corresponds to an analytical grouping (road-traffic crash and fall) used only in the sensitivity analysis. Polytrauma was defined as the association of the TSCI with at least one other significant extra-spinal traumatic lesion. ASIA grade on admission (A–E) was established according to the international ISNCSCI standards (8). The primary outcome was in-hospital mortality; neurological recovery, defined as a gain of at least one ASIA grade among survivors initially classified ASIA A–D, was a secondary outcome.

Statistical analysis: Categorical variables are expressed as counts and percentages, and quantitative variables as median and interquartile range, the distributions being skewed. Comparisons between mechanisms used the chi-square or Fisher test for proportions and the Kruskal-Wallis or Mann-Whitney tests for age. To limit the instability due to the small numbers in several categories, tests of proportions were conducted on an a priori grouping into three classes (road-traffic crash, fall, other mechanisms), the descriptive display remaining in six categories. No adjustment for multiple comparisons was applied, as the hypotheses were defined a priori. The significance threshold was set at $p < 0.05$ (two-sided).

The independent association of mechanism with mortality was estimated by Firth penalised logistic regression, preferred to conventional logistic regression to reduce the bias of maximum-likelihood estimates in the presence of infrequent events and a risk of quasi-complete separation (9) (10). Covariates were fixed a priori on clinical grounds: ASIA grade A, cervical involvement, polytrauma, age and sex. With 64 deaths for six variables, the events-per-variable ratio reached 10.7; substantial collinearity was ruled out (maximum variance inflation factor 1.05) and no automatic selection procedure was used. The interaction between the "high-energy" grouping and ASIA grade A was not significant ($p = 0.35$) and was not retained. All predicted probabilities came from the Firth penalised model used to estimate the odds ratios; conventional logistic regression was not used in parallel to produce performance measures. Discrimination was assessed by the area under the ROC curve and overall accuracy by the Brier score; calibration was described by the Hosmer-Lemeshow test, the slope and the intercept, the latter two obtained by auxiliary logistic regression of the outcome on the linear predictor of the Firth model. Internal validation by 500 bootstrap resamples, re-estimating the entire model at each draw, was used to estimate and correct the optimism of the area under the curve and of the calibration slope. No

external validation was performed (11). ASIA grade was included in the model not to estimate the total effect of mechanism, but to assess its residual direct effect once initial neurological severity, regarded as the proximal clinical determinant of prognosis, is known (Figure 2) (12). This is therefore an adjustment for a variable lying on the causal pathway, answering a precise clinical question rather than estimating a total causal effect; the odds ratios must not be interpreted as relative risks. Two sensitivity analyses were conducted: the first contrasted high-energy trauma with other mechanisms, the second directly compared the two best-represented mechanisms. No data were missing for the model variables, incomplete records having been excluded during the preliminary audit; the admission date, however, is missing for 127 patients (34.7%), which limits only the analyses by period. No a priori sample-size calculation was performed and the cohort was not prospectively registered. Analyses were conducted with Python 3.12, the Firth regression relying on an implementation of maximum likelihood penalised by the Jeffreys penalty (9).

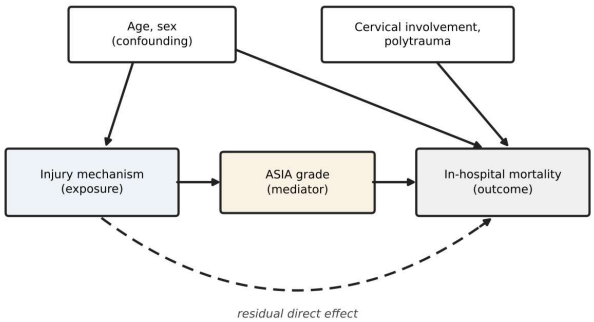


Figure 2. Directed causal graph of the prognostic model. Injury mechanism is a distal determinant; ASIA grade, a proximal determinant, lies on the causal pathway and is a potential mediator. Adjustment for this variable estimates the residual direct effect of mechanism

Ethical considerations: The study was conducted in accordance with the Declaration of Helsinki. The protocol was approved by the Institutional Ethics Committee of the Bouaké University Hospital Center (opinion no. CEI/CHU-BKE/149/2026), which granted a waiver of individual consent (retrospective study, anonymised routine records). The data were anonymised before analysis.

RESULTS

Sociodemographic profile and injury mechanisms: The cohort comprised 366 patients, with a median age of 35 years (IQR 26–47; range 4–83) and a marked male predominance (296/366; 80.9%; male-to-female ratio 4.2), the 15–44 age group accounting for 262 patients (71.6%). The rural primary sector dominated the occupational profile: farming and livestock (104/366; 28.4%) and artisanal gold mining (49/366; 13.4%) together accounted for 41.8%, ahead of craftsmen and manual workers (50/366; 13.7%), trade (37/366; 10.1%), pupils and students (36/366; 9.8%), people without occupation (35/366; 9.6%), road transport (35/366; 9.6%) and salaried employment or civil service (20/366; 5.5%). Most patients (331/366; 90.4%) lived outside the city of Bouaké. Road-traffic crashes accounted for nearly two-thirds of TSCI (229/366; 62.6%), ahead of falls (95/366; 26.0%), assaults (20/366; 5.5%), work-related accidents (8/366; 2.2%), sports accidents (8/366; 2.2%) and other causes (6/366; 1.6%); high-energy trauma accounted for 88.5% of cases (Table 1). Mechanisms differed markedly by age: median age was 32 years (IQR 24–41) after a road-traffic crash versus 46 years (IQR 32–60) after a fall, the other mechanisms lying between 27 and 36 years (Kruskal-Wallis, $H = 34.32$; $p < 0.001$); victims of road-traffic crashes were younger than those of all other mechanisms combined (Mann-Whitney, $p < 0.001$). The sex ratio did not vary by mechanism ($p = 0.60$).

Mechanism and injury severity: Neurological severity did not differ significantly by mechanism. The proportion of complete injuries (ASIA grade A) was comparable after a road-traffic crash (42.8%) and after a fall (40.0%), and the proportion of severe injuries (ASIA grade A or B) was not higher after a road-traffic crash (53.3%) than after a fall (61.1%) ($p = 0.13$). Cervical involvement did not differ significantly by mechanism (52.8% after a road-traffic crash; $p = 0.20$). Polytrauma was present in 99 patients (27.0%), with no difference by mechanism ($p = 0.27$); among road-traffic crash victims, limb fractures were the main associated extra-spinal injury (21.8%), ahead of thoracic (19.7%), facial (9.2%) and abdominal (8.3%) trauma and pelvic fractures (7.4%). No mechanism was therefore associated with a specific initial neurological profile.

Care pathway and neurological recovery: The prehospital pathway differed by mechanism. Road-traffic crash victims were less often referred (66.8%) than those injured in a fall (74.7%) or by another mechanism ($p = 0.002$), and less often transported by non-medicalised means (44.5% versus 84.2% after a fall; $p < 0.001$), which suggests more frequent activation of emergency services after road crashes. The median delay between trauma and admission was two days (IQR 1–3) and did not differ by mechanism ($p = 0.97$). These differences, however, did not alter neurological outcome: among the 262 survivors initially classified ASIA A–D — the 40 survivors of grade E being excluded as unable to improve —, an improvement of at least one grade was observed in 120 patients (45.8%), namely 75/162 (46.3%) after a road-traffic crash, 30/67 (44.8%) after a fall and 15/33 (45.5%) for other mechanisms (chi-square = 0.046; $p = 0.98$).

In-hospital mortality and multivariable model: Overall in-hospital mortality was 17.5% (64/366). It reached 18.8% after a road-traffic crash and 20.0% after a fall, versus 5.0% after an assault and 0% after a work-related accident or other low-energy cause, the small numbers of the minority mechanisms requiring cautious interpretation. The comparison of the three mechanism classes did not reach the significance threshold ($p = 0.067$) and the direct comparison of road-traffic crashes with other mechanisms showed no excess mortality (OR 1.28; 95% CI 0.72–2.26; $p = 0.49$). When high-energy trauma ($n = 324$) was grouped against the other mechanisms ($n = 42$), crude mortality was higher in the former group (19.1% versus 4.8%; OR 4.73; 95% CI 1.11–20.11; $p = 0.036$), based on a small number of events in the low-energy group (2 deaths). After adjustment by Firth regression, this association no longer reached the significance threshold (adjusted OR 2.41; 95% CI 0.61–9.54; $p = 0.21$); the very wide confidence interval remains compatible with both no effect and a large effect, so that this analysis alone does not allow a conclusion (Table 4). A second sensitivity analysis directly comparing the two best-represented mechanisms showed no difference in mortality (18.8% versus 20.0%; $p = 0.92$).

Table 1. Characteristics of the 366 patients by injury mechanism

Mechanism	n	%	Median age (IQR), years	Men, %	ASIA A, %	ASIA A or B, %	Cervical involvement, %	Death, %
Road-traffic crash	229	62.6	32 (24–41)	79.5	42.8	53.3	52.8	18.8
Fall	95	26.0	46 (32–60)	82.1	40.0	61.1	48.4	20.0
Assault	20	5.5	36 (28–44)	95.0	10.0	30.0	50.0	5.0
Work-related accident	8	2.2	29 (24–37)	75.0	37.5	50.0	25.0	0.0
Sports accident	8	2.2	27 (21–34)	62.5	62.5	62.5	12.5	12.5
Other mechanism	6	1.6	35 (28–48)	100	16.7	50.0	50.0	0.0
Overall	**366**	**100**	**35 (26–47)**	**80.9**	**40.2**	**54.1**	**50.0**	**17.5**
p	—	—	**< 0.001**	**0.60**	**0.13**	**0.13**	**0.20**	**0.067**

P values refer to an a priori grouping into three classes (road-traffic crash, fall, other mechanisms): chi-square test for proportions, Kruskal-Wallis test for age (H = 34.32). ASIA = American Spinal Injury Association; IQR = interquartile range.

In the multivariable model (Table 2), ASIA grade A was the strongest independent determinant of mortality (adjusted OR 11.21; 95% CI 5.54–22.67), ahead of cervical involvement (OR 2.08; 95% CI 1.08–4.01; p = 0.028); polytrauma approached the threshold without reaching it (OR 1.87; 95% CI 0.98–3.57; p = 0.058). The estimate associated with mechanism remained close to unity and of acceptable precision (OR 0.92; 95% CI 0.46–1.84; p = 0.82). Apparent discrimination was satisfactory (AUC 0.860) and no major defect of overall calibration was detected (Hosmer-Lemeshow chi-square = 5.49; 8 df; p = 0.704; Brier score 0.104; McFadden pseudo-R^2 0.299; calibration slope 1.042; intercept 0.004). After 500 bootstrap resamples, the optimism-corrected area under the curve was 0.848 and the corrected slope 0.956 (Figure 3).

Table 2. Firth penalised logistic regression for in-hospital mortality

Variable	Adjusted OR	95% CI	p
ASIA grade A (complete injury)	11.21	5.54–22.67	< 0.001
Cervical involvement	2.08	1.08–4.01	0.028
Polytrauma	1.87	0.98–3.57	0.058
Road-traffic crash	0.92	0.46–1.84	0.816
Age (per standard deviation of 16.0 years)	0.83	0.60–1.15	0.262
Male sex	0.88	0.41–1.91	0.751

Sixty-four deaths among 366 patients; six covariates fixed a priori, i.e. 10.7 events per variable. Predicted probabilities and all performance measures come from the same Firth fit. Apparent performance: AUC 0.860; Brier score 0.104; McFadden pseudo-R^2 0.299; Hosmer-Lemeshow chi-square = 5.49 at 8 df, p = 0.704; calibration slope 1.042 and intercept 0.004. After 500 bootstrap resamples: corrected AUC 0.848 and corrected slope 0.956. No external validation. AUC = area under the ROC curve; CI = confidence interval; OR = odds ratio.

Table 3. Comparison of the two data-collection phases among the 239 patients whose admission date is recorded

Characteristic	Retrospective 2017–2021 (n = 76)	Prospective 2025–2026 (n = 163)	p
Median age, years	36	36	0.71
Men, %	80.3	78.5	0.89
Road-traffic crash, %	47.4	68.7	0.003
ASIA grade A, %	43.4	42.3	0.99
Cervical involvement, %	52.6	47.2	0.52
In-hospital death, %	9.2	10.4	0.95

The 127 patients whose admission date is not recorded are excluded from this table; their in-hospital mortality is 31.5% versus 10.0% among dated patients (p < 0.001), for a comparable initial neurological severity (35.4% versus 42.7% of ASIA A grades). Chi-square tests for proportions, Mann-Whitney test for age.

Table 4. Sensitivity analysis: Firth model substituting the "high-energy" grouping for mechanism

Variable	Adjusted OR	95% CI	p
ASIA grade A (complete injury)	11.48	5.62–23.51	< 0.001
Cervical involvement	2.03	1.06–3.92	0.033
Polytrauma	1.83	0.97–3.49	0.063
High-energy mechanism	2.41	0.61–9.54	0.212
Age (per standard deviation of 16.0 years)	0.84	0.61–1.16	0.289
Male sex	0.86	0.40–1.88	0.709

The "high-energy" grouping (road-traffic crash or fall) replaces mechanism, the other five covariates being unchanged. Apparent performance: AUC 0.856; Brier score 0.107; McFadden pseudo-R^2 0.288; Hosmer-Lemeshow chi-square = 2.06 at 8 df, p = 0.979; calibration slope 1.044 and intercept 0.005. After 500 bootstrap resamples: corrected AUC 0.840 and corrected slope 0.946.

EDITORIAL ACTION REQUIRED — Figure 3 is not included in the supplied file. Insert the ROC and calibration plots generated from the individual predicted probabilities of the fitted Firth model; do not create these plots without the underlying model predictions.

Figure 3. Performance of the multivariable Firth penalised model for the prediction of in-hospital mortality. (a) ROC curve based on the individual probabilities predicted by the main Firth model; the apparent area under the curve was 0.860. (b) Observed-predicted calibration by risk decile; the diagonal line represents perfect calibration. The apparent calibration slope was 1.042 and the intercept 0.004. After optimism correction by 500 bootstrap resamples, the AUC was 0.848 and the calibration slope 0.956.

DISCUSSION

To our knowledge, this cohort is the largest single-centre series devoted to injury mechanisms of traumatic spinal cord injury published in Côte d'Ivoire. It confirms the predominance of road-traffic crashes and describes a profile of young, economically active men, mostly engaged in primary-sector activity and living far from the referral centre. These results are consistent with series published in Nigeria, Benin, Cameroon and East Africa (3)-(5) (13)-(17): a reference Nigerian series reports an almost identical proportion of road-traffic crashes (62.6%) (5) and regional reviews confirm the pre-eminence of this mechanism and the strong male predominance (3) (4). Our in-hospital mortality (17.5%) is

higher than that of this Nigerian series (3.0%) (5) and of cohorts from high-resource settings (18) (19), which is probably explained by tertiary recruitment concentrating severe forms, the frequency of complete injuries (40.2%) and transport delays in a rural context (Table S1, supplementary material).

Mechanism, a marker of exposure and not of severity: The main contribution of this work lies in the demonstration that injury mechanism is an independent determinant of neither neurological severity nor in-hospital prognosis. After adjustment, no independent relationship was observed between mechanism and ASIA grade, spinal level, polytrauma or mortality. The epidemiological importance of road-traffic crashes is thus distinct from their individual prognostic value: mechanism appears to be a marker of exposure rather than a clinical biomarker of severity. This observation is pathophysiologically coherent. Between the circumstance of the trauma and neurological prognosis lie several determining steps: the energy actually transmitted to the spine, the direction of stresses, the type of fracture, osteoligamentous stability, the diameter of the spinal canal, the extent of spinal cord compression, secondary vascular lesions and the inflammatory response. Two patients victims of the same type of accident may therefore present radically different pictures. The causal chain can be summarised as follows: mechanism → transmitted energy → anatomical lesion → neurological deficit → prognosis. Mechanism is a distal determinant, ASIA grade a proximal one; a mechanism reputed to be high-energy does not systematically lead to more severe involvement.

Initial severity remains the determinant of prognosis: In-hospital mortality reached 35.4% in case of complete injury versus 5.5% for the other grades, i.e. an adjusted odds ratio close to eleven. Cervical involvement was also independently associated with it (adjusted OR 2.08) and polytrauma approached the threshold without reaching it (OR 1.87; $p = 0.058$): the determinants of prognosis are thus characteristics of the lesion itself, and not the circumstances in which it occurred. This result supports the use of ASIA grade as the main risk-stratification tool and agrees with the international literature, which identifies initial neurological deficit as the best predictor of outcome, the circumstances of the trauma losing their prognostic value after adjustment for severity (1) (2). The sensitivity analysis goes in the same direction without being able to settle the question alone: the association of the "high-energy" grouping no longer reaches the threshold after adjustment, but its interval remains too wide to exclude an effect. It is the comparison of road-traffic crashes with the other mechanisms, estimated with acceptable precision, that supports the main message.

Methodological considerations

ASIA grade lies on the causal pathway linking mechanism to death and is therefore a potential mediator rather than a mere confounder (Figure 2) (12). Adjustment for this variable amounts to estimating the residual direct effect of mechanism, and not its total effect. This choice is deliberate: it answers a precise clinical question — does mechanism retain its own prognostic value once neurological severity is known? — rather than the quantification of a total causal effect. The absence of a residual direct effect, together with the absence of an association of mechanism with neurological severity itself, indicates that the influence of mechanism on mortality, if any, passes entirely through initial injury severity. The conceptual classification of the model variables is detailed in the supplementary material (Table S2).

Clinical and public health implications: In resource-limited emergency departments, the mechanism of trauma should lead neither to overestimating nor to underestimating neurological severity: a standardised assessment according to the ASIA classification must be performed in all patients on admission. The demonstration of an absence of independent effect is a result in itself, in that it avoids using mechanism as a substitute for neurological assessment and recalls that the frequency of a mechanism is not the same as its individual prognostic value. The care pathway is moreover an original result: victims of road-traffic crashes were more often admitted directly and by medicalised transport, whereas falls, more often occurring in rural areas, were referred by non-medicalised means. These differences in access to emergency services, without altering initial severity or neurological outcome, argue for a homogeneous strengthening of prehospital pathways. Given the predominance of road-traffic crashes, primary prevention — motorcyclist safety, wearing of helmets and seat belts, speed control, action against drink-driving — remains the lever most likely to reduce the incidence of TSCI, whereas improving individual prognosis relies on early diagnosis, standardised neurological assessment and rapid specialised care.

Strengths and limitations: The strengths of this work lie in the size of the cohort, the preliminary audit of the database, the standardised neurological classification, reporting in accordance with the STROBE recommendations and the use of a penalised regression suited to infrequent events, with internal validation by bootstrap. Several limitations must be stressed. The single-centre, hospital-based nature limits generalisation and exposes to selection bias, as minor trauma and prehospital deaths are not represented, which may attenuate differences in mortality between mechanisms. Data collection in six categories does not allow distinguishing subtypes of road-traffic crash or quantifying kinetic energy, and the grouping of road-traffic crashes and falls under the term high energy does not take their biomechanical differences into account. The taxonomy has no category specific to artisanal mine collapses, although gold miners account for 13.4% of the cohort: these traumas are distributed across several categories, which may attenuate the truly observable heterogeneity. Misclassification remains possible where circumstances relied on statements by patients or their relatives, and the overall severity of polytrauma was not quantified with standardised scores, which were not available in the database.

The admission date was not recorded for 127 patients (34.7%) and these records show markedly higher mortality than dated records: the comparison between data-collection phases therefore concerns a non-representative subset and precludes any temporal analysis. As the primary outcome was in-hospital mortality, our conclusions concern early prognosis; 6-month and 1-year outcome fields exist in the database but, being partly reconstructed and unvalidated, they were not analysed. Model performance was subjected to optimism correction by resampling but to no external validation, and therefore remains to be confirmed. Finally, the small numbers of some mechanisms reduce power, and the residual imprecision can be read in the intervals: that of the crude odds ratio for road-

traffic crashes (0.72–2.26) excludes an effect greater than a doubling of the odds of death but not a moderate effect, whereas that of the "high-energy" grouping after adjustment (0.61–9.54) excludes almost nothing. Reproducibility will need to be confirmed by multicentre cohorts; the similarity of our results with other African series nevertheless suggests good transferability to comparable hospital settings.

CONCLUSION

In this Ivorian cohort of 366 patients, road-traffic crashes were the main mechanism of traumatic spinal cord injury, but no independent association with neurological severity or in-hospital mortality was demonstrated after adjustment, within the limits of precision of a cohort of this size. Initial ASIA grade remained the major prognostic determinant, alongside cervical involvement. These results support a dual strategy: primary prevention centred on road-traffic crashes and clinical stratification based on standardised neurological assessment from admission. Multicentre studies integrating prehospital data, accident subtypes and prolonged functional follow-up would allow prognostic models to be refined.

Authors' contributions

Y.B. Fionko conceived the study, performed the statistical analysis and wrote the first draft of the manuscript. R.A.Y. Diaby and S.K. Yao took part in data collection and verification and in the interpretation of the results. K.J.-J. Kouassi, D. Traoré and A. Simaga contributed to data collection and to the critical revision of the manuscript. A. Haidara supervised the work and carried out its critical revision. All authors read and approved the submitted version.

Ethical approval and consent

Study conducted in accordance with the Declaration of Helsinki. Protocol approved by the Institutional Ethics Committee of the Bouaké University Hospital Center (opinion no. CEI/CHU-BKE/149/2026), which granted a waiver of individual consent (retrospective study, anonymised routine records).

Consent for publication: Not applicable: the manuscript contains no identifying individual data, no image and no clinical detail that would allow a patient to be identified.

Data availability: The anonymised data underlying this study are available from the corresponding author on reasonable request.

Related publications: In accordance with ICMJE recommendations, the authors declare that this cohort of 366 patients has given rise to other manuscripts addressing different research questions (prognostic factors of mortality; AO Spine classification of injuries). These manuscripts are available to reviewers; no result, table or figure is reproduced from one manuscript to another.

Reporting: The study is reported in accordance with the STROBE checklist for cohort studies, attached to the submission file.

Funding: This work received no specific funding, public or private.

Conflicts of interest: The authors declare no conflicts of interest regarding the materials or methods used in this study or the results reported in it.

Abbreviations: ASIA = American Spinal Injury Association; AUC = area under the ROC curve; CI = confidence interval; IQR = interquartile range; ISNCSCI = International Standards for Neurological Classification of Spinal Cord Injury; OR = odds ratio; RTC = road-traffic crash; STROBE = Strengthening the Reporting of Observational Studies in Epidemiology; TSCI = traumatic spinal cord injury.

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