Original Article

Journal of Iranian Medical Council, Volume 9, Issue no. 1
http://dx.doi.org/10.18502/jimc.v9i1.20480

Transportation Modes and Prehospital Care: A Secondary Analysis of Vertebral Injury Patients

Samaneh Abiri[1], Esmaeal Rayat Dost[1], Navid Kalani[2], Lohrasb Taheri[3], Amir Hossein Pourdavood[4], Arman Hakemi[5], Behrang Rezvani Kakhki[6], Morteza Talebi Doluee[6], Mahdi Foroughian[6] and Shahram Shafa[7]*

1. Department of Emergency Medicine, Jahrom University of Medical Sciences, Jahrom, Iran
2. Research Center for Social Determinants of Health, Jahrom University of Medical Sciences, Jahrom, Iran
3. Department of Surgery, Jahrom University of Medical Sciences, Jahrom, Iran
4. Department of Surgery, Research Center for Noncommunicable Diseases, Jahrom University of Medical Sciences, Jahrom, Iran
5. Department of Emergency Medicine, Faculty of Medicine, Torbat Jam University of Medical sciences, Torbat Jam, Iran
6. Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical sciences, Mashhad, Iran
7. Department of Orthopedic Surgery, Jahrom University of Medical Sciences, Jahrom, Iran

*** Corresponding author**

Shahram Shafa, MD
Department of Orthopedic Surgery, Jahrom University of Medical Sciences, Jahrom, Iran
Tel: +98 9177916880
Email:
Sh.shafa@jums.ac.ir

Received: 26 Dec 2024
Accepted: 19 Apr 2025

Citation to this article
Abiri S, Rayat Dost E, Kalani N, Taheri L, Pourdavood AH, Hakemi A, et al. Transportation Modes and Prehospital Care: A Secondary Analysis of Vertebral Injury Patients. *J Iran Med Counc*. 2026;9(1):72-83.

Abstract

Background: Adequate prehospital care for Spinal Cord Injuries (SCI) is vital, influencing patient outcomes. Proper transportation plays an important role in minimizing delays and optimizing care. Thus, this study was aimed at evaluating the impact of transportation mode of vertebral injury patients on SCI.

Methods: In this secondary study of Jahrom city's vertebral injury cases (March 2021 to 2023), demographics, accident details, prehospital timelines, and classifying cases by transportation mode were highlighted. The key outcomes were spinal cord injury and the need for surgical intervention. Emphasizing spinal cord injury as the primary outcome, the aim was to find its correlation if exist with transportation type, adjustments were made on the severity and mechanism of accidents.

Results: There were 44 cases (58.6%) brought to hospital by Emergency Medical Services (EMS) and 31 cases (41.4%) who self-walked-in. There was a significant negative correlation between the time from admission to surgery and the time it takes for EMS to arrive at the scene (r=-0.409, p=0.006). There was a significant negative correlation between the GCS score during ambulation to the hospital and the time it takes for EMS to arrive at the scene (r=-0.290, p=0.041). Getting transferred between two hospitals was associated with delays in hospital arrival (p=0.036). EMS-referred patients had a higher incidence of spinal cord injury (25%) compared to self-referred patients (9.68%), though this difference was not statistically significant (p=0.134). Incidence of SCI in self-walked-in patients was statistically higher than EMS brought patients (p=0.013) only in falling down patients.

Conclusion: The data remains non conclusive about the issue that which method of arrival to hospital of being self-referred or being brought by EMS are superior.

Keywords: Accidental falls, Emergency medical services, Hospitals, Humans, Incidence, Spinal cord injuries, Walking

Introduction

Spinal Cord Injury (SCI) is a significant global health concern with varying incidence rates reported across studies (1). The reported incidence of SCI ranges between 10.4 and 83 cases per million inhabitants per year, highlighting the variability in prevalence worldwide. Traumatic causes, such as motor vehicle crashes and falls, are primary contributors to SCI, while non-traumatic etiologies include neoplasms, demyelinating diseases, and infectious diseases (2). The importance of understanding the epidemiology of SCI lies in its impact on public health, healthcare systems, and the affected individuals' quality of life. The consequences of SCI often result in long-term disabilities, necessitating extensive medical care and rehabilitation (3). Research on SCI epidemiology is crucial for informing preventive measures, healthcare planning, and resource allocation. Increased awareness about the causes and prevalence of SCI can aid in the development of targeted interventions to reduce the incidence of traumatic events leading to SCI (4).

SCI outcomes and prognosis are multifaceted, shaped by the interplay of factors such as injury severity, type, and timely medical intervention (5). Generally, motor recovery in SCI is challenging, with only a modest percentage showing improvement, particularly in cases like acute traumatic central cord syndrome (6). The severity of the injury stands out as a critical prognostic factor, determining the likelihood of ambulation outcomes. Prognostication becomes feasible within the initial 72 *hr* to one-month post-injury, allowing healthcare professionals to predict recovery trajectories based on early physical assessments (7). Maximizing functional outcomes is pivotal in SCI prognosis, emphasizing the importance of early rehabilitation efforts and interventions to achieve optimal levels of functional independence. Prognostic considerations extend beyond injury specifics, encompassing the completeness of the injury and the overall health of the individual (8).

Emergency Medical Services (EMS) play a pivotal role in shaping the outcomes of individuals with SCI. The timely response and expertise of EMS teams are critical factors that influence the prognosis and long-term effects of SCI (9). As first responders, EMS professionals conduct rapid assessments, administer spinal immobilization techniques, and ensure the swift transport of patients to specialized medical facilities (10). Their actions in the early stages of a spinal cord injury contribute to minimizing secondary damage, preventing complications, and facilitating efficient medical interventions (11). Proper spinal immobilization, including the use of collars and backboards, is paramount in reducing the risk of exacerbating spinal cord damage during transportation. EMS teams are trained to perform initial neurological assessments, providing crucial information for subsequent medical interventions and treatment planning (12). Ultimately, the efficiency and proficiency of EMS play a crucial role in improving the overall trajectory of the patient recovery and minimizing the long-term impact of SCI. The collaborative efforts of EMS in the pre-hospital phase contribute to better outcomes for individuals with SCI (13).

The timely arrival of an EMS team at the site of an accident holds paramount importance in determining the outcomes of SCIs. Swift response and timely intervention by EMS play a pivotal role in enhancing the prognosis for individuals with SCIs. Failure to receive prompt acute care from specialist spinal cord injury teams elevates the risk of secondary complications in traumatic SCI patients (14). Regarding the complex medical needs of individuals with SCIs, who frequently rely on EMS, the efficiency of the EMS response becomes critical in promptly and effectively addressing these needs, contributing to improved outcomes (15). The time taken from injury to arrival at a trauma center is a crucial parameter, with prolonged intervals potentially impacting overall SCI management and leading to complications and poorer outcomes (16). Acute management guidelines underscore the importance of prompt intervention in SCIs, and delays in EMS response may hinder the application of critical acute management strategies (17). Furthermore, timely EMS response not only addresses acute needs but also positively influences the subsequent rehabilitation process, reducing the burden on healthcare systems and enhancing overall well-being (18).

Studies, such as those conducted in European and Dutch Emergency Departments (EDs), highlight that self-referred patients often present with less severe conditions, yet a big proportion still require hospital-level care (19,20). For instance, research from a Dutch trauma center revealed that 51% of the self-referred patients needed emergency care, with motives ranging from perceived medical necessity to convenience (20). Similarly, in developing countries like Bangladesh, self-referral is prevalent, driven by inadequate primary care facilities and patient proximity to tertiary centers (21). Comparative analyses further underscore differences in outcomes between self-referred and Outpatient Department (OPD)-referred patients, with the latter often exhibiting higher admission rates and longer ED stays, suggesting more complex conditions (22).

Recent research on SCI consistently emphasizes the importance of prompt and effective prehospital care in reducing treatment delays and enhancing patient recovery. However, few studies have explored how different transportation methods—such as EMS versus self-transport—influence outcomes for individuals with spinal injuries. The current study addresses this oversight by examining the connection between transportation choices and the quality of prehospital care, specifically focusing on how these decisions impact the risk of spinal cord damage and the likelihood of requiring surgery. By analyzing whether EMS use or self-referral leads to better clinical results, this research fills a key gap in current knowledge. The aim is to inform more effective emergency response protocols, offering practical guidance for improving care strategies and patient outcomes in real-world settings.

Materials and Methods

This was a secondary research study of database of Jahrom city vertebral injury cases (March 2021 to 2023) (23). Ethical considerations (code of: IR.JUMS.REC.1400.022 from Jahrom university of medical sciences) were observed not to disclose identity of any individual patient. The inclusion criteria were confirmed cases of vertebral or SCI recorded in the Jahrom city database from March 2021 to December 2023, specifically those treated at Peymanieh Hospital in Jahrom, Iran, with complete demographic, clinical, and accident-related data, clearly documented modes of transportation to the hospital, and adherence to ethical guidelines. The excluded cases involved incomplete data and non-acute or chronic injuries. Based on this, all cases of the main dataset were retrieved. The cases were classified for mode of transportation to hospital to self-referred or brought by EMS. Self-referred refers to patients with vertebral injuries arrived at Peymanieh Hospital in Jahrom, Iran, without the assistance of EMS. These individuals walked into the hospital on their own or were transported by non-EMS means (*e.g.*, private vehicle, family, or bystanders) following their injury. Demographics, past medical histories, the accident characteristics such as the mechanism and severity, and prehospital timelines were selected for study.

Outcomes of interest were spinal cord injury incident and the need for surgical intervention. SCI was the worst outcome in discharge time that was selected as the main outcome to see its association with type of transportation to hospital. Most important co-variates were related to severity and mechanism of accident. Thus, mechanism of injury (road traffic accident/falling down and others), number of injured vertebra and the need for surgery were selected. Identifying cases that require surgical intervention provides information about the severity of vertebral injuries and the medical interventions needed. Surgical interventions are significant markers of critical cases and help guide treatment decisions by indicating the severity of vertebral injuries, prioritizing critical cases, and determining the appropriate medical approach, such as stabilization or decompression, to improve patient outcomes. Due to the lack of fracture classification in database, the need for surgical intervention was considered as a presentation of severity of injury. Vital signs on admission were captured to address any severity of event due to potential chance of neurologic shock in SCI. In patients brought by EMS, timelines of the events were captured for analysis.

Descriptive statistical analyses were performed utilizing SPSS 21. The data were succinctly presented through standard descriptive measures, encompassing counts (n), percentages (%), means, and Standard Deviations (SD). Pearson correlation coefficient was used to assess the correlation of continuous variables. Corrplot r package was utilized to visualize the correlation matrix. Chi-square was used to compare EMS brought and self-walked-in cases for categorical data and independent T test for continuous data. Injury time to Emergency room door was considered as an independent variable for the linear regression model. Logistic regression was used to compare EMS brought and self-walked-in cases for incident of outcome of interest SCI in crude model and in adjusted models for demographics, severity indicators, and falling height for falling down subgroups. The p-value of under 0.05 was considered statistically significant.

Results

Baseline characteristics of cohorts of EMS brought vs. self-walked-in patients

There were 44 cases (58.6%) who were brought hospital by EMS and 31 cases (41.4%) who self-walked-in. The comparison between patients brought in by EMS and those who self-referred showed no differences in almost all demographic and clinical characteristics, as shown in table Supplementary 1. The EMS-referred patients had a slightly lower mean age (40.11 years) compared to the self-referred patients (42.03 years), though this difference was not statistically significant (p=0.612), and both groups were predominantly male, with no significant differences in gender, occupation, marital status, race, education, physiological parameters, or Glasgow Coma Scale (GCS) scores (p>0.05). While the EMS-referred patients had a higher proportion of traffic accidents (68.18 *vs*. 45.16%; p=0.114) and more drivers involved in accidents (52.27 *vs*. 32.26%; p=0.984), there were no significant differences in fall height, injury severity, smoking history (38.71 *vs*. 22.73%; p=0.168), or chronic medical conditions, though the EMS-referred patients had a small percentage of pre-hospital interventions (2.27%) not observed in self-referred patients.

Both groups had comparable rates of TBI and burns, with no cases reported among self-referred patients. Additionally, there were no significant differences in the prevalence of orthopedic fractures or dislocations

Supplementary table 1. Characteristics of subjects with vertebral injury in Jahrom city dataset

		EMS		Self referred		p-value
		Mean/n	Standard deviation/%	Mean/n	Standard deviation/%	
Age (years)	-	40.11364	15.96248	42.03333	15.89726	0.612
Gender	Male	34	77.27	25	80.65	0.782
	Female	10	22.73	6	19.35	-
Occupation	Missing	3	6.82	3	9.68	0.862
	Freelance job	26	59.09	19	61.29	-
	Unemployed	2	4.55	1	3.23	-
	Soldier	1	2.27	0	0	-
	Military	0	0	1	3.23	-
	Teacher	0	0	1	3.23	-
	Employee	1	2.27	1	3.23	-
	Student	1	2.27	0	0	-
	Housewife	7	15.91	4	12.9	-
	Worker	1	2.27	1	3.23	-
	Out of service	1	2.27	0	0	-
	HCW	1	2.27	0	0	-
Marital	Single	11	25	10	32.26	0.293
	Married	30	68.18	21	67.74	-
	Divorced/widow	3	6.82	0	0	-

Contd. Supp table 1.

Race	Native	44	100	30	96.77	0.413
	Refugee	0	0	1	3.23	-
Educational	Illiterate	4	9.09	8	25.81	0.212
	Elementary	4	9.09	3	9.68	-
	High school	10	22.73	9	29.03	-
	Vocational school	4	9.09	0	0	-
	Diploma	18	40.91	7	22.58	-
	Associate degree	1	2.27	1	3.23	-
	Master	3	6.82	3	9.68	-
Pulse Rate (PR)	-	84.81818	12.93683	85.45161	15.90144	0.85
Systolic Blood Pressure (SBP)	-	114.0682	18.554	116.6129	15.35074	0.533
Diastolic Blood Pressure (DBP)	-	72.34091	10.89899	73.3871	8.503636	0.656
Respiratory Rate (RR)	-	18.84091	2.569437	19.06452	2.048341	0.688
Glasgow Coma Scale (GCS)	3	2	4.55	0	0	0.411
	10	1	2.27	0	0	-
	11	2	4.55	1	3.23	-
	12	0	0	1	3.23	-
	13	0	0	1	3.23	-
	15	39	88.64	28	90.32	0.508
GCS eye component	1	2	4.55	0	0	-
	2	1	2.27	0	0	-
	3	2	4.55	1	3.23	-
	4	39	88.64	30	96.77	-
GCS verbal component	1	2	4.55	1	3.23	0.893
	3	1	2.27	1	3.23	-
	4	3	6.82	1	3.23	-
	5	38	86.36	28	90.32	-
GCS movement component	1	2	4.55	0	0	0.234
	3	1	2.27	0	0	-
	4	2	4.55	0	0	-
	5	1	2.27	1	3.23	-
	6	38	86.36	30	96.77	-
Injury reason	Traffic accident	30	68.18	14	45.16	0.114
	Fall	10	22.73	15	48.39	-
	Other traumatic causes	3	6.82	2	6.45	-
	Suicide	1	2.27	0	0	-
Fall height (m)		2.6	1.429841	3.5	2.564551	0.328

Contd. Supp table 1.

Patient position in accident	Cyclist	11	25	3	9.68	0.55
	Passenger	18	40.91	10	32.26	-
	Passerby	1	2.27	1	3.23	-
Patient role in accident	Driver	23	52.27	10	32.26	0.984
	Passerby	6	13.64	3	9.68	-
Type of accident	Overturning	18	40.91	5	16.13	0.197
	Collision	12	27.27	9	29.03	-
Accident to	Car/Van	8	18.18	7	22.58	0.217
	Motorcycle	1	2.27	0	0	-
	Heavy transport vehicle	3	6.82	0	0	-
	Missing	0	0	1	3.23	-
Air bag opening	No	27	61.36	13	41.94	0.989
	Opened	1	2.27	0	0	-
Aim of trip that caused accident	Income-generating business activity	11	25	13	41.94	0.212
	Other (education, cleaning, *etc.*)	26	59.09	17	54.84	-
	Unknown	1	2.27	0	0	-
	Recreational activity	6	13.64	1	3.23	-
Pre-hospital cardiac arrest	Yes	1	2.27	0	0	0.999
Pre-hospital CPR	Yes	1	2.27	0	0	0.999
Intubation	Yes	2	4.55	0	0	0.999
Airway status	Yes	0	0	2	6.45	0.161
Past medical history of cardiac diseases	Yes	6	13.64	1	3.23	0.392
Hypertension (HTN)	Yes	2	4.55	1	3.23	0.354
Chronic Obstructive Pulmonary Disease (COPD)	Yes	0	0	2	6.45	0.161
Smoking	Yes	10	22.73	12	38.71	0.168
Diabetes Mellitus (DM)	Yes	1	2.27	1	3.23	0.999
Chronic Kidney Disease (CKD)	Yes	0	0	0	0	0.999
Psychological disease	Yes	1	2.27	0	0	0.999
Osteoprosis	Yes	0	0	0	0	0.999
Rheumatological-diseaase	Yes	1	2.27	0	0	0.999
Type of vertebral injury	Penetrating	41	93.18	30	96.77	0.999
	Blunt	2	4.55	1	3.23	-

Contd. Supp table 1.

Traumatic Brain Injury (TBI)	Yes	2	4.55	2	6.45	0.999
Burn	Yes	0	0	0	0	0.999
Orthopedic fracture or dislocation of other bones	Yes	13	29.55	9	29.03	0.999
Isolate spinal injury	Yes	28	63.64	21	67.74	0.999
Internal bleeding	Yes	4	9.09	2	6.45	0.88
Spinal cord injury	Yes	11	25	3	9.68	0.134
Spinal cord injury type	Missing	1	2.27	1	3.23	0.852
	Hemiplegia	1	2.27	0	0	-
	Parapartic	1	2.27	1	3.23	-
	Paraplegic	4	9.09	1	3.23	-
	Quadri plegic	1	2.27	0	0	-
	Hemiparesis	1	2.27	0	0	-
	Patrick Quadri	1	2.27	0	0	-
	Quadri plegic	1	2.27	0	0	-
No. of vertebral injuries		1.54	0.87	1.3	0.7	0.225
Between hospital transfer	Yes	2	4.55	3	9.68	0.643
Hospitalization length		9.246799	22.45156	5.075622	8.475411	0.266
Admission to surgery		9.555556	7.584707	10.14286	5.610365	0.861
MV days		9.75	7.5	5.5	2.12132	0.497
VAS pin		6.5	1.951331	6.636364	2.110579	0.869
ICU length of hospitalization		2.24	5.93	1.33	3.69	0.505
Mechanical Ventilation (MV)	Yes	4	9.09	2	6.45	0.999
Death	Death	3	6.82	3	9.68	0.687
Urinary incontinence	Yes	11	25	4	12.9	0.255
Fecal incontinence	Yes	10	22.73	4	12.9	0.377
CSF leakage in hospital	Yes	0	0	0	0	0.999
Bedsore in hospital	Yes	0	0	0	0	0.999
Fever in hospital	Yes	0	0	0	0	0.999
Traction	Yes	0	0	0	0	0.999
Surgical intervention	1	12	27.27	9	29.03	0.999
Fusion bone parts	0	0	0	1	3.23	0.179
	1	4	9.09	6	19.35	-
	2	1	2.27	0	0	-
	3	5	11.36	1	3.23	-
Pulmonary-thrombo Embolism (PTE) prophylaxis	Yes	2	4.55	5	16.13	0.119

of other bones and internal bleeding between the two groups (p>0.05).

Characteristics of EMS responses

Figure 1 shows the timelines of EMS responses in 44 EMS brought cases. In this analysis, the goal was to identify factors that influence the time it takes for patients to arrive at the hospital after an injury. A variety of potential predictors were examined, including demographic factors (such as age, gender, occupation, marital status, and educational level), clinical factors (such as smoking status and physiological measures like pulse rate, systolic and diastolic blood pressure, and respiratory rate), and contextual factors. None of these variables—age, gender, occupation, marital status, education, smoking status, or physiological measures—were found to have a significant impact on the time it took for patients to reach the hospital.

However, one factor stood out as significant: the time taken for transfers between hospitals. The analysis revealed a significant positive association (β=30.16, SE 13.33, p=0.036), meaning that when patients were transferred from one hospital to another, this process was associated with delays in their arrival at the final hospital. In other words, hospital-to-hospital transfers contributed to longer overall arrival times. This finding is highlighted in table 1 of the study, suggesting that inter-hospital transfers are a critical factor to consider when evaluating delays in hospital arrival following an injury.

Outcomes of interest

EMS-referred patients had a higher incidence of spinal cord injury (25%) compared to self-referred patients (9.68%), though this difference was not statistically significant (p=0.134). The difference in surgical intervention rates between the two groups was not statistically significant (p=0.999), as shown in table 2.

Crude analyses indicated that the incidence of SCI in self-walked-in patients was statistically higher than EMS brought patients (p=0.013) only in falling down patients. In the analysis, after adjusting for variables such as age, gender, PR, RR, SBP, and DBP, the type of EMS referral (self-walked-in *vs*. EMS-brought patients) showed no significant effect on the incidence of SCI in the subgroup of traffic accident patients (p=0.471). Similarly, in the subgroup of the patients who experienced falls, even after adding the height of the fall to the model, there was no significant effect of referral type on the incidence of SCI (p=0.056). These results, as presented in table 3, indicate that the mode of referral (self-walked-in or EMS-brought) did not significantly influence the likelihood of SCI in either traffic accident or fall-related injury cases after accounting for the specified variables.

Discussion

The main finding was that 9.68% of the patients who had vertebral injury and had referred to hospital by themselves experienced SCI. The theoretical hypothesis of this issue is that self-walked-in referral

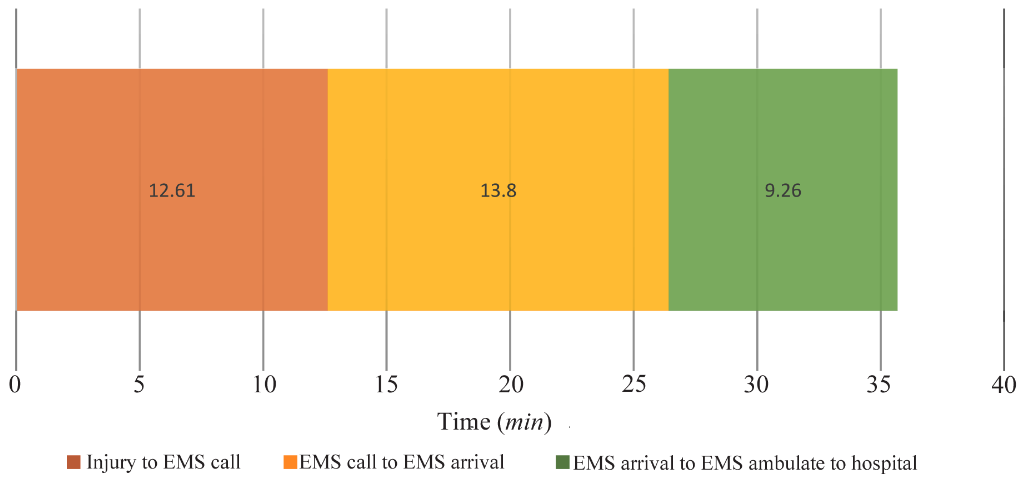

Figure 1. Timelines of EMS reactions to SCI incidents.

Table 1. Linear regression between the study variables and time of incident to hospital

	Beta	SE	t	p-value
Age	0.58	0.43	1.37	0.187
Gender	2.11	9.24	0.23	0.822
Occupation	1.39	1.07	1.3	0.21
Marital status	-15.27	10.54	-1.45	0.164
Educational status	0.01	3.43	0	0.997
Smoking status	-5.52	8.34	-0.66	0.516
PR	0.43	0.23	1.89	0.074
SBP	-0.31	0.29	-1.06	0.302
DBP	-0.45	0.48	-0.93	0.362
RR	-2.68	1.76	-1.53	0.143
Injury mechanism	2.53	5.53	0.46	0.653
Scene GCS	0.4	1.11	0.36	0.72
TBI	13.15	28.05	0.47	0.645
Type of vertebral injury	11.65	19.01	0.61	0.547
MV	1.96	18.51	0.11	0.917
Death	-5.68	13.82	-0.41	0.686
Between hospital transfer	30.16	13.33	2.26	0.036
Spinal cord injury	-4.98	9.4	-0.53	0.602

Table 2. Comparison of SCI and surgery of SCI among the study groups

	EMS brought		Self-walked-in		p-value
	n	%	n	%	
Spinal cord injury	11	25	3	9.68	0.134
Surgical intervention	12	27.27	9	29.03	0.999

to hospital might have caused incomplete SCI to a full SCI due to non-adhering to roles of immobilization of the spine. However, there were no differences between EMS brought and self-walked-in patients in any clinical or demographic variables. Patients have the right to refuse medical assistance (24), but EMS is responsible for the safety of the patients and handling these situations is being a challenge (25).

In this study, several significant correlations were

Table 3. Logistic regression analysis of SCI incidence in traffic and falling down injuries

Model	Subgroup	Outcome: SCI			p-value
		OR	95%CI		
			Lower	Upper	
Crude	Traffic accident	1.2	0.203	7.105	0.841
Crude	Falling down	21	1.922	229.392	0.013
Adjusted by age, gender, PR, SBP, DBP, RR, need for surgery	Traffic accident	2.159	0.267	17.47	0.471
Adjusted by age, gender, PR, SBP, DBP, RR, need for surgery, falling down height	Falling down	60.393	0.894	4.078	0.056

Pulse Rate (PR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Respiratory Rate (RR).

observed between the physiological variables (*e.g.*, heart rate, respiratory rate, blood pressure, and GCS scores) and EMS response times or injury outcomes. The correlation analyses presented in this study were not merely exploratory; they were conducted to build a nuanced understanding of the relationships between the key variables, which was essential for developing a robust regression analysis framework. The primary objective was to compare the outcomes between the self-referred and EMS-referred trauma patients, but to do so meaningfully, it was needed to account for the complex interplay of the physiological, temporal, and injury-related factors that could confound or mediate these comparisons so that regression model was adjusted for age, gender, PR, SBP, DBP, RR, need for surgery, and falling down height.

While all patients of the study who were transported by EMS undergone spine immobilization, there were protocols for selective immobilization of trauma cases for some cases with low risk of injuries. The findings from a systematic review reveal that there were no occurrences of neurological deterioration observed in patients with spine injuries who were not immobilized during prehospital care (26). This issue might have been the reason of no differences in the outcomes between EMS brought and self-walked-in patients due to differences in injury severity or mechanism of the accidents.

The current study's findings both align with and diverge from previous research on self-referred *vs.* EMS-transported patients. Similar to the studies in European and Dutch EDs, which found that self-referred patients often present with less severe conditions but still require significant hospital-level care (19,20), the present study suggested that self-referred patients had a lower incidence of SCI compared to EMS-transported patients, though this difference was not statistically significant after adjustments. However, unlike the Dutch trauma center study, which reported that 51% of the self-referred patients required emergency care due to perceived medical necessity or convenience (20), this study found no significant difference in the need for surgical intervention between the two groups, suggesting that injury severity and prehospital timelines may be more influential than the mode of arrival. In the developing countries like Bangladesh, where self-referral is prevalent due to inadequate primary care and proximity to tertiary centers (21), and the current study similarly highlights the role of systemic healthcare challenges in shaping patient outcomes. Finally, while comparative analyses have shown that OPD-referred patients often have more complex conditions, leading to higher admission rates and longer ED stays (22), the current study found no such disparity in outcomes between self-referred and EMS-transported patients, emphasizing the need for tailored prehospital care strategies that account for injury mechanisms and patient-specific factors rather than relying solely on the referral patterns.

The study highlights critical correlations between EMS response times and patient outcomes. Longer EMS arrival times correlate with prolonged hospital transfers ($r=0.654$, $p<0.001$) and delayed surgery ($r=-0.409$, $p=0.006$), while shorter responses are linked to higher GCS scores during ambulation ($r=-0.290$, $p=0.041$) and admission ($r=-0.310$, $p=0.033$). Delayed EMS exacerbates neurogenic shock in SCI, impairing spinal cord perfusion and increasing secondary injury risks (30). Faster EMS responses improve surgical timing and neurological recovery (31), while delays heighten hypotension risks, further compromising outcomes (32).

Conclusion

In conclusion, the findings of this study suggest that the mode of transportation—whether by EMS or self-referral—does not conclusively determine the incidence of SCI or the need for surgical intervention in vertebral injury patients, after adjusting for demographic and physiological variables. While EMS-referred patients exhibited a higher incidence of SCI, this difference was not statistically significant, indicating that factors such as injury severity, mechanism of accident, and prehospital timelines may play a more critical role in outcomes than the transportation mode itself. The negative correlation between EMS arrival time and both time to surgery and GCS scores during ambulation highlights the importance of timely EMS response in optimizing care, particularly in reducing delays for surgical intervention. However, the lack of significant differences in SCI incidence between the two groups after adjustments suggests that prehospital care protocols, rather than the transportation method alone, may be pivotal in influencing patient outcomes.

Ethical approval

The ethical code provided by Jahrom University of Medical Sciences is IR.JUMS.REC.1400.022.

Acknowledgement

The authors thank the Clinical Research Development Unit of Peymanieh Educational and Research and Therapeutic Center, Jahrom University of Medical Sciences, Jahrom, Iran for providing facilities for this work.

Conflict of Interest

Authors declare no conflict of interest.

References

1. Kang Y, Ding H, Zhou H, Wei Z, Liu L, Pan D, et al. Epidemiology of worldwide spinal cord injury: a literature review. J Neurorestoratol 2018;6(1):3.

2. Kim HS, Lim KB, Kim J, Kang J, Lee H, Lee SW, et al. Epidemiology of spinal cord injury: changes to its cause amid aging population, a single center study. Ann Rehabil Med 2021;45(1):7-15.

3. Wyndaele M, Wyndaele JJ. Incidence, prevalence and epidemiology of spinal cord injury: what learns a worldwide literature survey? Spinal Cord 2006;44(9):523-9.

4. Khadour FA, Khadour YA, Meng L, XinLi C, Xu T. Epidemiology features of traumatic and non-traumatic spinal cord injury in China, Wuhan. Sci Rep 2024 Jan 18;14(1):1640.

5. Ding W, Hu S, Wang P, Kang H, Peng R, Dong Y, et al. Spinal cord injury: the global incidence, prevalence, and disability from the global burden of disease study 2019. Spine (Phila Pa 1976) 2022;47(21):1532-40.

6. Parthiban J, Zileli M, Sharif SY. Outcomes of Spinal Cord Injury: WFNS Spine Committee Recommendations. Neurospine 2020;17(4):809-19.

7. Van Middendorp JJ, Goss B, Urquhart S, Atresh S, Williams RP, Schuetz M. Diagnosis and prognosis of traumatic spinal cord injury. Global Spine J 2011;1(1):1-8.

8. Burns AS, Marino RJ, Flanders AE, Flett H. Clinical diagnosis and prognosis following spinal cord injury. Handb Clin Neurol 2012;109:47-62.

9. Chay W, Kirshblum S. Predicting outcomes after spinal cord injury. Phys Med Rehabil Clin N Am 2020;31(3):331-43.

10. Sharif S, Ali MY. Outcome prediction in spinal cord injury: myth or reality. World Neurosurg 2020;140:574-90.

11. Hawkridge K, Ahmed I, Ahmed Z. Evidence for the use of spinal collars in stabilising spinal injuries in the pre-hospital setting in trauma patients: a systematic review. Eur J Trauma Emerg Surg 2022;48(6):4759-73.

12. Chen HA, Hsu ST, Shin SD, Jamaluddin SF, Son DN, Hong KJ, et al. A multicenter cohort study on the association between prehospital immobilization and functional outcome of patients following spinal injury in Asia. Sci Rep 2022;12(1):3492.

13. Alghamdi I, Bazaie N, Alqurashi N, Ahmed Z. The impact of prehospital spinal immobilization in patients with penetrating spinal injuries: a systematic review and meta-analysis. Trauma Care 2022;2(2):226-37.

14. Ahn H, Singh J, Nathens A, MacDonald RD, Travers A, Tallon J, et al. Pre-hospital care management of a potential spinal cord injured patient: a systematic review of the literature and evidence-based guidelines. J Neurotrauma 2011;28(8):1341-61.

15. White CC IV, Domeier RM, Millin MG; Standards and Clinical Practice Committee, National Association of

EMS Physicians. EMS spinal precautions and the use of the long backboard—resource document to the position statement of the National Association of EMS Physicians and the American College of Surgeons Committee on Trauma. Prehosp Emerg Care 2014;18(2):306-14.

16. Kupfer M, Kucer BT, Kupfer H, Formal CS. Persons with chronic spinal cord injuries in the emergency department: a review of a unique population. J Emerg Med 2018;55(2):206-12.

17. Arleth T, Rudolph SS, Svane C, Rasmussen LS. Time from injury to arrival at the trauma centre in patients undergoing interhospital transfer. Dan Med J 2020;67(9):A03200138.

18. Gosney JE, Reinhardt JD, von Groote PM, Rathore FA, Melvin JL. Medical rehabilitation of spinal cord injury following earthquakes in rehabilitation resource-scarce settings: implications for disaster research. Spinal Cord 2013;51(8):603-9.

19. Elshove-Bolk J, Mencl F, van Rijswijck BT, Simons MP, van Vugt AB. Validation of the Emergency Severity Index (ESI) in self-referred patients in a European emergency department. Emerg Med J 2007;24(3):170-4.

20. Van der Linden MC, Lindeboom R, van der Linden N, van den Brand CL, Lam RC, Lucas C, et al. Self-referring patients at the emergency department: appropriateness of ED use and motives for self-referral. Int J Emerg Med 2014;7:28.

21. Hasan MJ, Rafi MA, Nishat NH, Islam I, Afrin N, Ghosh B, et al. Patient self-referral patterns in a developing country: characteristics, prevalence, and predictors. BMC Health Serv Res 2024;24(1):651.

22. Chou YR, Ma MC, Lee CC, Hsieh CC, Lin CH. Comparison of OPD-referral and self-referral patients in the emergency department.

23. Rayatdoost E, Rahmanian V, Sadeghi M, Adnani M, Kazeminezhad A. Characterizing spinal cord injuries in Jahrom, Iran: a registry study from 2021 to 2023. Updates Emerg Med 2023;3(1).

24. Al-Wathinani AM, Barten DG, Alsahli H, Alhamid A, Alghamdi W, Alqahtani W, et al. The Right to Refuse: Understanding healthcare providers' perspectives on patient autonomy in emergency care. Healthcare (Basel) 2023;11(12):1756.

25. Tavakol N, Tavakol M. Professionalism in pre-hospital emergency care: a case study of care refusal. Updates Emerg Med 2023;3(2).

26. McDonald NE, Curran-Sills G, Thomas RE. Outcomes and characteristics of non-immobilised, spine-injured trauma patients: a systematic review of prehospital selective immobilisation protocols. Emerg Med J 2016;33(10):732-9.

27. Pham H, Puckett Y, Dissanaike S. Faster on-scene times associated with decreased mortality in helicopter emergency medical services transported trauma patients. Trauma Surg Acute Care Open 2017;2(1):e000122.

28. Hosseinzadeh A, Kluger R. Do EMS times associate with injury severity? Accid Anal Prev 2021;153:106053.

29. Azadeh MR, Parvaresh Masoud M, Gaeeni M, Hamta A. Outcomes of traffic accident patients transferred by air and ground ambulance: propensity score matching. Health Emerg Disasters Q 2021;7(1):21-32.

30. Sharwood LN, Dhaliwal S, Ball J, Burns B, Flower O, Joseph A, et al. Emergency and acute care management of traumatic spinal cord injury: a survey of current practice among senior clinicians across Australia. BMC Emerg Med 2018;18(1):57.

31. Hagen EM. Acute complications of spinal cord injuries. World J Orthop 2015;6(1):17-23.

32. Wang TY, Park C, Zhang H, Rahimpour S, Murphy KR, Goodwin CR, et al. Management of acute traumatic spinal cord injury: a review of the literature. Front Surg 2021;8:698736.