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ORIGINAL ARTICLE

# Epidemiological Evaluation of Patients with Spinal Cord Injury Referred to the Legal Medicine Organization of Mashhad in 2021

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## Abstract

**Introduction:** Spinal cord injuries caused by trauma are one of the most disabling public health challenges of society. This study was conducted to investigate the epidemiology of spinal cord injuries in the forensic medicine referees of Mashhad, Iran, during one year.

**Methods:** This retrospective cross-sectional study was conducted at Razavi Khorasan Forensic Medicine Center (Iran) in 2021. The hospital records of the patients related to intensive care units, emergency, orthopedics, neurosurgery, and rehabilitation departments, which were available in the forensic medical records of the patients, were reviewed. The sampling method in this research was considered a one-year census. Data analysis was performed using chi-square using SPSS software (version 26).

**Results:** This study examined 52 cases of spinal cord injury with a mean age of 36±12 years, 32.7% of whom were women and 67.3% were men. The most common injury mechanisms were, respectively, traffic accidents (77.60%), work accidents (12.20%), and struggle (5.8%). A total of 37.17% of patients had injuries in the thoracic vertebrae, 31.85% in the lumbosacral, and 30.97% in the cervical vertebrae. The most frequently damaged vertebra was the twelfth thoracic vertebra (10.62%), followed by the second lumbar vertebra (9.73%) and the fifth cervical vertebra 8.85%). After one year of injury, 65.4% of the patients had bedsores. In general, 48.8% of the patients were heads of households and were responsible for caring for 1 to 5 people.

**Conclusion:** Most of the spinal cord injured patients are young men of working and production age who need continuous care and supportive measures after injury. The costs of caring for these patients are high, and after receiving the initial compensation, they do not have any further financial or social support. Moreover, the caregivers of these people need training on how to care for the patient to prevent complications such as bedsores and infections. Knowledge of epidemiological factors can facilitate the design and planning of ways to prevent such injuries.

**Key words:** Epidemiology, Nervous system, Spinal cord injuries, Trauma, Traffic accidents

## Introduction

Spinal cord injuries caused by trauma are one of the most disabling public health challenges of society. The leading cause of these injuries, especially in the young population of society, has always been motor vehicle accidents. Since these injuries lead to severe disabilities, it imposes a

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heavy burden on healthcare systems (1). Spine fractures, among other types of injuries, have more effects on the social and economic status of the affected people. Spinal cord injury seriously endangers the physical, mental, and social health of people through the impact on the autonomic system and sense and movement (2, 3). Since there is currently no definitive treatment for spinal cord injury, prevention of traumatic spinal injuries is the most effective way to prevent spinal disabilities. Knowledge of the epidemiological characteristics of spinal cord injuries can help to adopt preventive and cost-effective strategies to reduce the incidence and burden of the disease (4, 5).

More than 90% of cases of spinal cord injuries are caused by physical damage factors, such as road traffic accidents, falls, and violence (7). Men between the ages of 20 to 29 years and 70 years and above are more exposed to spinal cord injuries, while women in the age group of 15 to 19 years and from the age of 60 years and above are more at risk for spinal cord injuries. The highest death rate from this type of injury is observed in low- and middle-income countries (8). Several studies have been conducted on the prevalence of spinal cord injury, the mechanisms of spinal cord injury, and its complications, from which we can refer to the research by Golestani et al., which showed that in developing countries, spinal cord injuries are more common among young people and especially among men (8).

According to the head of the country's Welfare Organization, there are about 27000 people with spinal cord injuries in the country (9). Unfortunately, a precise statistical analysis that provides a correct estimate of the number of people with spinal cord injuries has not been done yet. Therefore, due to the limited local information available in this field, the present study was conducted with the aim of epidemiological investigation of spinal cord injuries to facilitate planning to prevent such injuries in the studied community.

## Methods

The present retrospective cross-sectional study was conducted at Razavi Khorasan Forensic Medicine Center (Iran) in 2021. This study was authorized by the ethics committee of the Legal Medicine Organization under the number IR.LMO.REC.1398.019. The hospital records of the patients related to intensive care units, emergency, orthopedics, neurosurgery, and rehabilitation departments, which were available in the forensic medical records of the patients, were reviewed. The sampling method in this research was considered a census for one year.

First, the required information was collected from the files through a checklist designed by the researchers in the form of two forms, A and B. The face and content validity of these forms have been confirmed by related experts. Form A included demographic characteristics of patients, including age, gender, marital status, education level, history of previous diseases, type of accident, place of occurrence, etc. This information was extracted from the files by the researchers, and the cases that were not available in the files were completed by calling the telephone numbers of the patients listed. Form B contained the details of the injuries extracted and completed from the patient's hospital records. The inclusion criteria were having a spinal cord injury, and the criteria for exclusion were the presence of a brain injury along with the spinal cord injury, or unwillingness to cooperate and answer the interview questions. Additionally, patients who died before reaching the hospital were not included in the study. Finally, a total of 52 patients referred to Mashhad forensic medicine during the year 2021 were included in this study. The collected data were analyzed statistically using SPSS version 26 software. The data analysis of this study was conducted in the descriptive part using mean, frequency, percentage, and variance statistics and in the analytical part with the help of the chi-square test. The significance level (P-value) was considered less than 5% in all calculations.

## Results

This study was conducted on a total of 52 patients referred to the Mashhad Legal Medicine Center of Razavi Khorasan Province in Iran. The average age of these patients was 36±12 years old (the oldest patient was 59 and the youngest patient was 10 years old), and the highest percentage of injured people were in the age group of 19 to 44 years (65.4%) and 45 to 65 years old (26.9%). Children (up to 12 years old) and teenagers (over 12 to 18 years old) constituted 1.90 and 5.80 percent of the injured, respectively. Moreover, 35 cases were male (67.30%), and 17 were female (32.70%). In addition, 51.2% of the injured people were under the care of others, while 48.8% were heads of households and were responsible for caring for 1 to 5 people (with an average of 1.23 people). The place of residence of 82.4% of the injured individuals was urban, while 17.6% lived in rural areas. Most patients (42.3%) had a primary education level, and

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illiterate individuals comprised 9.6% of the population. The frequency of those with a diploma and university education was 32.7% and 15.4%, respectively. Regarding marital status, 26.9% of the population were single, 69.2% were married, and 3.8% were divorced after the injury.

Verifying the type of accident leading to spinal cord injuries in individuals showed that 77.6% of the injuries were related to traffic accidents, 12.2% were related to work accidents, 6.1% were related to fights, and 4.1% were related to other incidents. The data indicated that in 6 cases of traffic accidents (16.2%), the type of vehicle involved was a motorcycle, and in 1 case (2.7%), it was a bicycle. The condition of the helmet was known for four motorcycle riders, and only one of them was wearing a helmet during the accident. In terms of the type of vehicle among the traffic accident victims, 59.5% were driving cars, 5.4% were in sport utility vehicles (SUVs), 10.8% were in heavy vehicles, and 5.4% were pedestrians. Of the car riders involved in traffic accidents, only half reported their seat belt status at the time of the incident, which indicated that 73% of them were not wearing their seat belt at the time of the accident. 57.6% of accidents leading to spinal cord injury occurred on intercity roads, 24.2% on inner city roads, and 18.2% on village roads. The type of road in 53% of cases was a two-way road. 28% were highways, and 15.6% were gravel roads.

In terms of employment status, most patients were self-employed (40%), followed by housewives (23.1%) and workers (17.3%). Students and the unemployed each constituted 5.8% of the affected population, while retirees had the lowest job frequency at 1.9%.

Evaluation of vertebral column injuries revealed that the most commonly affected vertebrae were T12, L2, L1, and C5, with frequencies of 10.62%, 9.73%, 8.85%, and 8.85%, respectively. After them, T11 (7.08%), C6 (6.19%), C4 (5.31%), and C7 (5.31%) vertebrae demonstrated the highest prevalence of injuries. According to the available results, in general, the prevalence of injuries was as follows: Thoracic vertebrae (37.17%), cervical vertebrae (30.97%), lumbar vertebrae (29.20%), sacral vertebrae (1.77%), and coccyx (0.88%). (Figure 1).

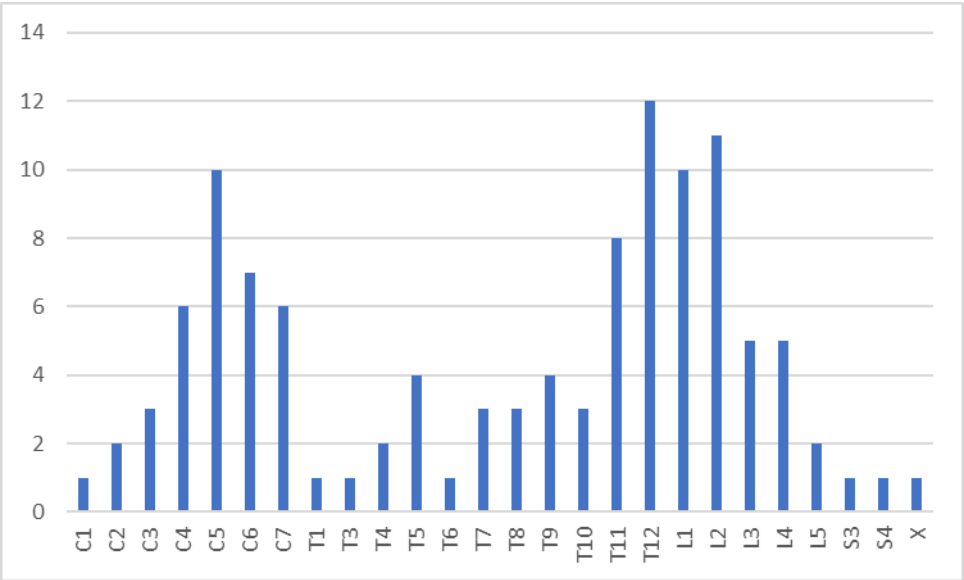


**Figure 1. Scatter diagram of levels of vertebral damage in patients with spinal cord injury referred to Mashhad Legal Medicine Center (Iran). The x-axis number represents the count of damaged vertebrae**

The severity of patients' injuries was estimated according to the Frankel scale (Table 1). Based on this assessment, 51% of the injured patients had grade A injuries, 7.8% had grade B injuries, 23.53% had grade C injuries, and 11.76% had grade D injuries.

Some people had several accompanying traumas, of which 37% were related to the limbs, 31% to the chest, 18% to the abdomen, 10% to the head and face, and 4% to the pelvis, respectively. In addition, the results of the data analysis indicated that there is a significant relationship between not using a seat belt and sustaining accompanying trauma (P=0.019, Table 2).

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**Table 1. The Frankel Scale for Spinal Cord Injury That Classifies the Extent of the Neurological/Functional Deficit into Five Grades**

| Frankel Scale | | |
|---|---|---|
| A | Complete | No motor or sensory function below level of lesion |
| B | Sensory only | No motor function, but some sensation preserved below level of lesion |
| C | Motor useless | Some motor function without practical appliction |
| D | Motor useful | Useful motor function below level of lesion |
| E | Recovery | Normal motor and sensory function, may have reflex abnormalities |

**Table 2. Relationship between using or not using a seat belt and sustaining accompanying trauma**

| Variable | | Sustaining accompanying trauma | | |
|---|---|---|---|---|
| | | No | Yes | Total |
| Using a Seat Belt | No, N(%) | 2(12.5) | 14(87.5) | 16(100.0) |
| | Yes, N(%) | 3(60.0) | 2(40.0) | 5(100.0) |
| Pearson Chi-Square | | Value | df | Sig |
| | | 5.538 | 1 | 0.019 |

Evaluating the complications that happened in patients showed that one year after injury, 65.4% of them developed bed sores.

Out of a total of 52 injured people, the recovery status of 35 individuals was assessable, of which 32 people (91.4%) had no sensory-motor recovery. The number of people who recovered was 3 (8.7%) from Frankel injury levels A (41 years old), C (29 years old), and D (41 years old), who recovered to Frankel levels C, D, and E, respectively.

## Discussion

This study has been conducted with the aim of epidemiological investigation of spinal cord injuries following accidents leading to spinal column damages. Considering that spinal cord injuries lead to lifelong disability in patients, their epidemiological investigation can play an essential role in improving standards and helping to prevent these accidents.

In the present study, the average age of patients was estimated to be 36 years, and the most common age range of patients with spinal cord injury was young people in the range of 18 to 40 years old. In Golestani et al.'s review article (2022), the most common age range of patients with spinal cord injury was under 30 years old (8). In an article by Ning et al. in 2010, the average age of the subjects was 46 years. In their study, two age ranges were the most prevalent, which were 46 to 60 years and 61 to 75 years, respectively. They also demonstrated that falling from a height was the leading cause of injury, and after that, traffic accidents were the second (10). Meanwhile, in the current study, 77.6% of cases suffered from spinal cord injury after a traffic accident. This issue can justify the difference in the age range in these studies because, in Iran, the highest prevalence of road accidents is among young and middle-aged people, whereas in developed countries, the life expectancy is higher, and the prevalence of falls among the elderly is greater (6).

In the present study, 32.7% of patients were women, 67.3% were men, and the male-to-female ratio was 2.05 to 1. In a study in Tehran (Iran) that investigated the epidemiological characteristics of traumatic spinal cord injuries (TSCI), 20.8% of people were women, and 79.2% of cases were men, and the ratio of men to women in that study was 3.8 (11). From the total findings, it can be concluded that this result can be due to the higher level of social activity in men, which exposes them to traffic accidents to a greater extent than women.

In the present study, most injured patients (42.30%) had primary education, and illiterate patients constituted 9.6% of the population. The frequency of diploma and university education was 32.70% and 15.40%, respectively. Educational level can be considered as a risk factor for certain causes of spinal cord injuries. Derakhshan Rad et al. reported that there was a correlation between the causes of spinal cord injury and the educational level of the injured patient. For instance, fighting and violence in people with a lower educational level were the leading cause of injury, while educated people had more sports accidents (11).

In the present study, the most common injury mechanisms were traffic accidents (77.60%), work accidents (12.20%), and struggle (5.8%), in respective order. A total of 46.1% of traffic accidents were car accidents, and 11.5% of them were motorcycle accidents. Jiang et al. (2021) observed in a study that 55.2% of spinal cord injury cases occurred due to falls from a height, followed by 26.5% of cases happened because of motor vehicle accidents (12). Moreover, Tafida et al. reported that the main cause of spinal injuries in the past was traffic accidents, which has now been replaced by

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falls from a height (13). This difference in the causes can be due to the difference in the safety standards of the cars used, road and road standards, and the driving culture of the people.

In the present study, 37.17% of patients had injuries in the thoracic vertebrae, 31.85% in the lumbosacral vertebrae, and 30.97% in the cervical vertebrae, respectively. In a study in China, the percentage distribution of injuries in cervical, thoracic, and lumbosacral regions was reported as 20.45%, 30.49%, and 49.05%, respectively (14). In the present study, it was found that the T12, L2, L1, and C5 vertebrae had the most prevalent injuries among the vertebrae, with frequency values of 10.62%, 9.73%, 8.85%, and 8.85%, respectively. In the study by Wong et al., the L1, T12, and C2 vertebrae had the highest frequency of injuries (19.2%, 11.3%, and 8.3%, respectively) (15).

According to the results obtained from the follow-up of the patients, after one year, 65.4% of the patients developed pressure sores. Haisma et al., in a study on 212 patients with spinal cord injuries, demonstrated that 49% of patients were hospitalized due to urinary tract infections, and 36% of them were hospitalized again due to pressure ulcers (16). Other studies have considered these two complications the most important in these patients (17). In addition, in the series of cases studied by Wang et al., the most prevalent complications were pulmonary infection and bed sores (15). This shows the high importance of paying attention to the prevention and treatment of bed sores. The difference in the incidence of bed sores in the mentioned studies and the present study can be due to the lack of proper care of the patient at home and the lack of distance health services and proper training for the patient's family and caregivers in the studied community.

In the population studied here, 83.8% of patients with spinal cord injury had accompanying trauma in other parts of the body. Limb trauma has the highest prevalence (37%), followed by chest trauma (31%), abdomen (18%), head and face (10%), and pelvis (4%). In the study by Wong et al. (2012), chest trauma followed by limb trauma had the highest prevalence rate; however, they reported the prevalence rate of accompanying trauma as 30.36% in general (14). In the mentioned study, the most common cause of spinal cord injury was falling from a height. Therefore, the difference in the prevalence of accompanying traumas can be because traffic accidents lead to multiple injuries.

Other studies have also reported chest trauma with a higher prevalence than other injuries (18). In their study, Price et al. stated that the reason for the lower number of bodily injuries in traffic accidents is the strength of the car structure (19). This issue depends on the standards of cars used in different countries.

The co-occurrence of traumatic brain injury (TBI) and spinal cord injury (SCI), known as "dual diagnosis," complicates clinical treatment and rehabilitation. A study by Gober et al. assessed the prevalence of comorbid TBI among children hospitalized for SCI between 2016 and 2018 in the hospitals of the United States participating in the Kids' Inpatient Database. They found that 38.8% of these children also had a comorbid TBI. The study highlighted the high prevalence of TBI among children with SCI, underscoring the need for further research on the effects of dual diagnosis on mortality, quality of life, and functional outcomes (20). In our study, the prevalence of accompanying head and face injuries was only 10%.

The most important limitation of this research was the small sample size; therefore, it is appropriate to repeat this study with a larger sample size prospectively.

## Conclusions

Epidemiological studies aim to prevent injuries and enhance the quality of life for accident survivors. The overall incidence rate of TSCI is approximately 26.48 (95% CI, 24.15–28.93) per million people (21). Notably, many spinal cord injury patients face significant financial challenges, with nearly half being heads of households. After their initial compensation, they often lack ongoing financial support and may become disabled. Consequently, supportive institutions, such as insurance companies and social security organizations, need to strategically plan to alleviate the suffering of these patients and their families, preventing secondary complications due to inadequate treatment funding. Additionally, caregivers should receive continuous training on patient care to manage potential complications like bed sores and infections effectively. Understanding epidemiological factors can facilitate the development of effective preventive measures.

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## Conflict of Interest

The authors declare no conflicts of interest in this study.

## References

1. Oliver M, Inaba K, Tang A, Branco BC, Barmparas G, Schnüriger B, et al. The changing epidemiology of spinal trauma: a 13-year review from a level I trauma centre. Injury. 2012;43(8):1296-1300.
2. Leucht P, Fischer K, Muhr G, Mueller EJ. Epidemiology of traumatic spine fractures. Injury. 2009;40(2):166-172.
3. Singh A, Tetreault L, Kalsi-Ryan S, Nouri A, Fehlings MG. Global prevalence and incidence of traumatic spinal cord injury. Clin Epidemiol. 2014; 6:309-331.
4. McCammon JR, Ethans K. Spinal cord injury in Manitoba: a provincial epidemiological study. J Spinal Cord Med. 2011;34(1):6-10.
5. Rahimi-Movaghar V, Saadat S, Rasouli MR, Ganji S, Ghahramani M, Zarei MR, et al. Prevalence of spinal cord injury in Tehran, Iran. J Spinal Cord Med. 2009;32(4):428-431.
6. Rabiei A, Tabesh H. Epidemiological study of vertebral trauma in Isfahan Province during 2012-2018. Feyz Med Sci J. 2019;23(1):102-107.
7. Organization WH, Society ISC. International perspectives on spinal cord injury: World Health Organization. 2013.
8. Golestani A, Shobeiri P, Sadeghi-Naini M, Jazayeri SB, Maroufi SF, Ghodsi Z, et al. Epidemiology of traumatic spinal cord injury in developing countries from 2009 to 2020: a systematic review and meta-analysis. Neuroepidemiology. 2022;56(4):219-239.
9. The National Welfare Organization in the media, An annual addition of 2,000 people to the population of people with spinal cord injuries due to traffic accidents. Available from: https://behzisti.ir/x7HX. [Accessed: Feb. 26, 2025].
10. Ning GZ, Yu TQ, Feng SQ, Zhou XH, Ban DX, Liu Y, et al. Epidemiology of traumatic spinal cord injury in Tianjin, China. Spinal Cord. 2011;49(3):386-390.
11. Derakhshanrad N, Yekaninejad MS, Vosoughi F, Sadeghi Fazel F, Saberi H. Epidemiological study of traumatic spinal cord injuries: experience from a specialized spine center in Iran. Spinal Cord. 2016;54(10):901-907.
12. Jiang B, Sun D, Sun H, Ru X, Liu H, Ge S, et al. Prevalence, incidence, and external causes of traumatic spinal cord injury in China: a nationally representative cross-sectional Survey. Front Neurol. 2021; 12:784647.
13. Tafida MA, Wagatsuma Y, Ma E, Mizutani T, Abe T. Descriptive epidemiology of traumatic spinal injury in Japan. J Orthop Sci. 2018;23(2):273-276.
14. Wang H, Zhang Y, Xiang Q, Wang X, Li C, Xiong H, et al. Epidemiology of traumatic spinal fractures: experience from medical university-affiliated hospitals in Chongqing, China, 2001-2010. J Neurosurg Spine. 2012;17(5):459-468.
15. Wang H, Liu X, Zhao Y, Ou L, Zhou Y, Li C, et al. Incidence and pattern of traumatic spinal fractures and associated spinal cord injury resulting from motor vehicle collisions in China over 11 years: an observational study. Medicine (Baltimore). 2016;95(43): e5220.
16. Haisma JA, van der Woude LH, Stam HJ, Bergen MP, Sluis TA, Post MW, et al. Complications following spinal cord injury: occurrence and risk factors in a longitudinal study during and after inpatient rehabilitation. J Rehabil Med. 2007;39(5):393-398.
17. Stillman MD, Barber J, Burns S, Williams S, Hoffman JM. Complications of spinal cord injury over the first year after discharge from inpatient rehabilitation. Arch Phys Med Rehabil. 2017;98(9):1800-1805.
18. Wang H, Zhou Y, Ou L, Li C, Liu J, Xiang L. Traumatic vertebral fractures and concomitant fractures of the rib in southwest China, 2001 to 2010: an observational study. Medicine (Baltimore). 2015;94(44): e1985.
19. Price C, Makintubee S, Herndon W, Istre GR. Epidemiology of traumatic spinal cord injury and acute hospitalization and rehabilitation charges for spinal cord injuries in Oklahoma, 1988-1990. Am J Epidemiol. 1994;139(1):37-47.
20. Fallah N, Noonan VK, Sharwood LN. Editorial: epidemiology, evidence-based care, and outcomes in spinal cord injury. Front Neurol. 2024; 15:1383757.
21. Lu Y, Shang Z, Zhang W, Pang M, Hu X, Dai Y, et al. Global incidence and characteristics of spinal cord injury since 2000–2021: a systematic review and meta-analysis. BMC Med. 2024;22(1):285.

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