

# Epidemiological Characteristics of Traumatic Spinal Cord Injury in Shaanxi, China

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## Research Article

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# Abstract

**Study Design.** A hospital-based retrospective epidemiological study.

**Summary of Background Data.** TSCI is a highly disabling and deadly injury. Currently, there is little information regarding the epidemiological characteristics for TSCI in Shaanxi.

**Objective:** To describe the demographic and epidemiological characteristics of patients with traumatic spinal cord injury (TSCI) in Shaanxi to help health-related institutions formulate corresponding measures.

**Methods.** We retrospectively reviewed the medical records of the spine centers or orthopedic centers of the four cities in Shaanxi province according to the International Classification of Disease Version 10 (ICD-10) and diagnostic code of TSCI. Variables included gender, age, medical insurance, etiology, occupation, time of injury, level of injury, and severity of injury, multiple injury, treatment, and so on.

**Results:** The study included the medical records of 694 patients with TSCI in 2018. The mean age of patients with TSCI was  $48.4 \pm 14.9$  years, and the male/female ratio was 3.45:1. The major causes of TSCI were high falls (40.2%) and low falls (26.7%). The most common injury site was the cervical spinal cord, accounting for 48.7%. The highest proportion of severity of injury was ASIA Grade D (37.8%). In addition, 74.6% of the patients had spinal fractures, the chest (38.0%) accounted for the highest proportion of all TSCI patients. Furthermore, 27.8% of the patients experienced clinical complications. 530 (76.4%) patients underwent surgery, 323 (46.5%) patients underwent inpatient rehabilitation.

**Conclusion:** There are specific epidemiological characteristics of TSCI patients in Shaanxi, and preventive measures are suggested to be based on the characteristics of the different types of patients with TSCI and focused on high-risk groups.

## Introduction

Spinal cord injury (SCI) is highly disabling. It puts a heavy burden on individuals, families and society as a whole because of its labour loss, long-term rehabilitation, occupation of large medical resources and expensive medical costs. Throughout the world, developed countries in Europe and the United States have identified the epidemiological characteristics of traumatic SCI (TSCI) through domestic large-scale investigations. Although injury prevention initiatives have attempted to reduce the occurrence of TSCI, the incidence and prevalence of TSCI have been increasing, with the annual incidence rate estimated at 10.4 to 83 cases per million in North America and Western Europe.[1] A study conducted in Canada found that between January 1997 and June 2001, the incidence of TSCI was 42.4 per million among people aged 15 to 64 years and 51.4 per million among people over the age of 65 years.[2] According to reports, the average annual incidence of TSCI in the United States is 53–54 cases per one million persons.[3] Koskinen et al. reported that the mean annual incidence of TSCI in Finland was 25.1 per million, and in the hospital districts of the SCI centers, the incidence was even higher, at 38.1 per million.[4]

In China, studies reported an annual incidence rate of 23.7 per million population in Tianjin[5] and 60.6 per million in Beijing[6]. The epidemiological characteristics of TSCI vary across regions with different economic levels, and economic periods. It is of great importance to conduct such epidemiological research at the local population level. China is a rapidly developing country, Shaanxi is the province with the largest population and the highest-level economy in northwest China. However, at present, very little is known and reported about the epidemiological research on TSCI in Shaanxi. Therefore, our hospital-based retrospective study aimed to examine the demographics and epidemiological characteristics of patients with TSCI in Shaanxi to help health-related institutions develop measures to determine the best allocation of medical resources, in order to ease financial and social burdens.

## Methods

### Study Design and Participants

To our knowledge, a regional population-based registry system of total TSCI has not yet been developed in Shaanxi; thus, we included the provincial capital Xi'an and randomly selected three other cities in Shaanxi (Hanzhong, Baoji, Xianyang). We retrospectively reviewed the medical record data of the spine centers or orthopedic centers of these four cities in 2018, using the International Classification of Diseases Version 10 (ICD-10) and diagnostic code of TSCI. Inclusion criteria: (1) meet the diagnostic criteria for TSCI; (2) patients admitted to hospital from January 1, 2018 to December 31, 2018; (3) TSCI occurred in Shaanxi; (4) there were in-hospital medical records with complete key information. Exclusion criteria: (1) non-TSCI; (2) patients who died before hospitalization; (3) emergency department patients who were never hospitalized and (4) referrals between sampled hospitals only recorded the first time. The Ethics Committee of Xi'an Honghui Hospital and the ethics committee of each participating center approved the current study.

### Data collection

### Questionnaires

Referring to the relevant methods of epidemiological research on TSCI globally, the experts at Xi'an Honghui Hospital designed a medical record questionnaire. According to the rationality, scientificity, necessity and feasibility of the investigation project, multiple rounds of argumentation, modification and field trials were performed until the collected information sufficiently reflected the epidemiological characteristics of TSCI in Shaanxi. Then, the final version of the questionnaire was created, and the corresponding database was established.

The following survey indicators were finalized: 1. general information of patients (name, age, gender, ID number, occupation, residence address, medical insurance, telephone number); 2. relevant information of the TSCI (date of injury, cause of injury, date of admission, injury level, severity of injury, with spinal fracture or not); 3. multiple injuries; 4. treatment options (surgery or rehabilitation, surgical procedures and approach); 5. clinical complications; and 6. death and the cause of death. The patients were divided into

eight age groups:  $\leq 15$ , 16 to 25, 26 to 35, 36 to 45, 46 to 55, 56 to 65, 66 to 75, and  $\geq 76$  years. Occupations were categorized as civil servants, professional technicians, enterprise staff, workers, peasants, students, freelancers, self-employed individuals, unemployed individuals, retired individuals, and all other occupations not classified above. The etiologies included injuries caused by traffic accidents, sports, low falls (height  $\leq 1$  m), high falls (height  $>1$  m), and other causes. The levels of injury were divided into cervical spinal cord, thoracic spinal cord, and lumbosacral spinal cord. A complete injury was defined as the absence of sensory and motor function in the lowest sacral segments.

## Quality control

Experienced investigators were selected to participate in data collection. Relevant personnel were repeatedly trained before data collection, a manual of procedures was distributed, and detailed instructions for administration of the questionnaires and data entry were provided. In the investigation stage, two investigators were assigned to the investigation unit in each city, and they separately extracted and verified the data and signed the questionnaire as the responsible party for the authenticity of the data. Any problems encountered by investigators in the investigation of medical records must be solved through timely discussion and consultation with experts. Strict review of completed questionnaires, and re-examination of unqualified questionnaires to ensure the quality of the data entered. In the data entry phase, a double entry verification system was adopted. After all data were entered, the epidemiologist checked the database data, and the investigator traced the discovered abnormal values back to the paper questionnaire or even the original medical records to determine the source and to correct the error value generated during the data extraction process.

## Statistical analysis

We used Epidata software (version 3.1) for data entry and management and used Microsoft Office Excel 2019 to check and save data. Analyses were performed with SAS (version 9.1). The measurement data were expressed by absolute value and mean  $\pm$  standard deviation, and the classification data and ranked data were expressed by absolute value, rate and composition ratio. Chi-squared tests were used to examine the differences between the categorical variables, t tests were employed to assess the differences between the normally distributed continuous variables, and Wilcoxon rank-sum tests were applied to examine the differences between the non-normally distributed continuous variables. All statistical tests were two-sided, and a P value less than 0.05 was considered significant.

# Results

## General Characteristics of Patients With TSCI

All 15 hospitals in the 4 cities participated in the survey. A total of 694 eligible cases were collected, with an average age of  $48.4 \pm 14.9$  years old, a male to female ratio of 3.45:1, and males accounting for 77.5%. The highest proportion of TSCIs occurred in the 46-55 age group (25.6%), followed by the 36 to 45-year-old group (20.5%), and 25.4% of TSCI cases did not have spinal fracture or dislocation. The most

common occupational groups were peasants, and workers, accounting for 71.2% of the total. Regarding medical insurance, 42.5% (295 cases) of all patients with TSCI have to pay for their own expense and 38.0% (264 cases) used rural cooperative medical care insurance. The general characteristics are shown in Table 1.

### **Etiology of the injuries**

As shown in **Figure 1a**, the leading causes of TSCI in Shaanxi are high falls (40.2%), and the other two important causes are traffic accidents (22.8%) and low falls (26.7%). Observing the distribution of the cause of injury (**Figure 1b**), we found that in the 16-25 age group, the highest cause was high falls (57.5%), which tended to decrease with increased age. The proportion in the  $\geq 76$  age group reached 25.0%. The proportion of low falls in the 16-25 age group was 7.5%, and they increased with age and reached 58.3% ( $\geq 76$  age group). The leading cause of injury in the level of cervical spinal cord was low falls (36.4%), in the level of thoracic spinal cord and lumbosacral spinal cord was high falls (49.2%, 58.5%), respectively (**Figure 1c**).

### **Injury level**

The most common injury that patients with TSCI suffered was a cervical injury (338 cases), which accounted for 48.7% of all cases, followed by thoracic and lumbar injuries

(132 and 224 cases, respectively) (**Figure. 2a**). There was a tendency for cervical SCI to increase with age, and the proportion in the  $\geq 76$  age group (66.7%) was the highest. The proportions of lumbosacral SCI decreased with increasing age and were only 8.3% in the  $\geq 76$  age group (**Figure 2b**).

### **Severity of injury**

The highest proportion of severity of injury in the included TSCI patients was incomplete quadriplegia (38.5%), followed by incomplete paraplegia (33.7%). The ASIA (American Spinal Injury Association) grade was used to quantify the severity of injury, with the highest proportion being ASIA Grade D (37.8%), followed by ASIA Grade A (26.8%) (**Figure 3a**). However, four grades did not show a clear trend with age (**Figure 3b**). In addition, the leading ASIA Grade in patients with major causes such as traffic injuries, low falls and high falls are Grade D (36.2%, 44.9%, 35.9%, respectively) (**Figure 3c**). The distribution of ASIA grade in different injury level was also different. the leading ASIA Grade in patients with cervical spinal cord and lumbosacral spinal cord were Grade D (37.3%, 47.8%, respectively). However, in patients with thoracic spinal cord was Grade A (56.1%) (Figure 3d).

### **Level and type of fracture**

74.6% (518 cases) of TSCI cases with spinal fracture or dislocation. The most common level of fracture that patients with TSCI suffered was a lumbosacral (34.5%), followed by cervical and thoracic (31.8%, 33.8%). The proportion of TSCI combined with cervical and thoracic vertebrae fractures in all age groups gradually increased with age, up to 45.5%, 45.5%, respectively ( $\geq 76$  age group), while the proportion of

lumbosacral vertebrae fractures gradually decreased with increasing age, with the lowest at 9.1% ( $\geq 76$  age group) (Figure 4a). In the cervical spine, the C5 (6.5%) and C6 (8.4%) vertebral bodies were more commonly combined with fractures, and the major fracture type was dislocation. T12 (12.2%) has the high proportion of fractures in the thoracic spine, and burst fractures are main fracture type. In the lumbar spine, L1 (14.8%) and L2 (7.4%) were easily combined with fractures, and the fracture type was mainly burst (Figure 4b).

### Multiple injuries

With regard to combined multiple injuries, the chest (38.0%) accounted for the highest proportion of all TSCI patients, followed by the head (31.6%) and limbs (19.7%) (Figure 5a). Except insufficient data in  $\geq 76$  age group, the distribution of multiple head and chest injuries in rest age groups showed a trend of increasing with age, up to 40.7% (66-75 age group), 43.1% (56-65 age group), respectively. Multiple limb and pelvic injuries showed a tendency to decrease with increasing age (Figure 5b). The distribution of multiple injuries in different cause of injury was also different. The leading multiple injuries in patients caused by traffic accidents and high falls are chest (34.0%, 40.1%, respectively). However, in patients caused by low falls is head (45.0%) (Figure 5c).

### Clinical Complications

27.8% (193 cases) of patients with TSCI experienced clinical complications, in which, 51.3% had respiratory complications, followed by electrolyte disorder (25.9%) and venous thrombosis (21.8%) (Figure 6a). The main clinical complication is still respiratory system, even in different ASIA grades or injury level (Figure 6b-c).

### Treatment Options

530 (76.4%) patients underwent surgery treatment, and the main surgical procedure was decompression, fixation and bone graft fusion, a total of 423 (79.8%) patients (Table 2). Regarding the surgical approach, 117 (22.1%) patients underwent anterior surgery and 390 (73.6%) patients underwent posterior surgery. 323 (46.5%) patients underwent inpatient rehabilitation. The average length of hospital stay was  $17.9 \pm 17.2$  days for all patients,  $18.7 \pm 15.8$  days and  $17.6 \pm 17.7$  days for patients with complete SCI and incomplete SCI, respectively. The differences in the number of patients with and without complete injury who accepted rehabilitation therapy were statistically significant ( $P < 0.05$ ). However, the differences in the receipt of surgery therapy and length of hospital stay between these two groups was not statistically significant ( $P > 0.05$ ).

### Death and the cause of death

Seven (1.0%) patients died during hospitalization. 4 (57.1%) males of them, and the oldest was 80 years old. Of these 7 patients, 71.4% (5 cases) died from respiratory failure. The injury level of 5 (71.4%) dead patients was in the cervical spinal cord, 3 (42.9%) dead patients with cause of high falls, and 3 (42.9%) dead patients with cause of traffic accidents.

## Discussion

TSCI imposes a substantial burden on individuals, their families, and society because of the cost of health care treatments, rehabilitation, and lost productivity. To our knowledge, the current study is the first hospital-based retrospective study on TSCI in Shaanxi Province. We conducted this study to add the information about the demographics and epidemiological characteristics of patients with TSCI in Shaanxi for the optimal allocation of medical resources and to provide improved medical services to patients with TSCI.

We found that the average age of Shaanxi TSCI patients ( $48.4 \pm 14.9$ ) was higher than the global average age of TSCI (33 years)[7], which was also higher than the average age of Chinese TSCI patients reported in the previous review[8]. Previous studies have shown that the age of patients with TSCI has a bimodal distribution[9–11], and this study had a unimodal distribution for age. Most of the injuries were in the 46–55 age group (25.6%), followed by the 36–45 age group (20.5%), which shows that adults are still the main population that have TSCI. We also found that men in Shaanxi have a higher risk of suffering from TSCI than women (3.45:1). which is in accordance with a previous study on TSCI conducted in Chongqing[12]. According to other countries' data, for patients with TSCI, the ratio of male to female was 2.3–2.8:1 in the United States from 1993–2012[3]; in Australia from 2002–2012 was approximately 1.5–2.4:1. The main reason is that most women are housewives with low-risk occupations, but men are more likely to engage in high-risk work outdoors[9, 10]. The imbalance between men and women in China may be one of the factors that make their male-female ratio slightly higher than other countries.

Moreover, this study revealed that the main etiologies of TSCI in Shaanxi included high falls (40.2%), low falls (26.7%), traffic accidents (22.8%), Compared with those of a 2011 report from Tianjin[5] and a 2017 report from Guangdong [13], we all sure high falls was leading cause in most city of China. High falls mainly occurred in construction sites, and the Chinese government has increased economic support to the North Western region in recent years and vigorously developed infrastructure construction. The construction unit needs to strengthen the individual's awareness of safety and security, focus on monitoring the safety and quality of production, and provide a safe working environment. Low falls as a second cause in Shaanxi and a tendency increase with increased age means low-energy injuries mainly occurred in the elderly, therefor, falls prevention of older people needs more attention than other risk factors. Especially, we found that the main cause of cervical spinal cord injury was low falls (36.4%).

The most common level of injury observed in the current study was cervical injuries, which accounted for 48.7% of the total cases, which is in accordance with a previous study[9, 14, 15]. However, for the first time, we found that the proportion of cervical SCI increased significantly with age. The possible reason for the analysis is that the degeneration and hyperplasia of the cervical vertebrae are obvious with the increase in age. The cervical spinal canal stenosis is caused by the disc herniation and ossification of the ligamentum flavum, and the volume of the spinal canal for compensation is significantly reduced during the trauma; thus, even low-energy trauma, such as a low fall, can easily cause damage to the spinal cord. We also found that the proportion of low falls continues to increase with age.

Regarding the severity of the injuries, we used ASIA grade to quantify it. ASIA D (37.8%) still is the main grade, followed by ASIA A (26.8%). We found that the most important ASIA grade of patients with cervical SCI is grade D, while the most important ASIA grade of patients with thoracic spinal cord injury is Grade A. This may be because the majority of elderly patients who with cervical SCI suffer from low-energy injury such as low falls. However, the thoracic spine and ribs constitute the thorax with good stability, usually in the condition of high-energy injury can cause thoracic spinal cord injury, and the severity of injury is often more serious.

TSCI with spinal fracture is more common. C5 and C6 vertebrae were more common in cervical spinal fracture, and L1 and L2 vertebrae are more common in lumbar spinal fracture, showing a bimodal distribution. This finding is consistent with previous research conclusions[12, 16], but we further studied the types of fractures and found that the most common fracture form of C5 and C6 vertebrae was dislocation, and the fracture types of T12 vertebrae and L1 and L2 vertebrae were mainly burst fractures. We first found that the proportion of TSCI with cervical spine fractures increased with age, and the proportion of lumbar fractures decreased with increasing age. This may be because with the increase in age, people's bones are gradually becoming looser, and they are slow-moving, have decreased vision, slow protective emission, etc., which makes it easier to fall. A large number of studies have confirmed that low falls are the most common cause of cervical fractures in elderly patients[17, 18], and the rising proportion of falls we found that cause injury with age better explains the above situation. Previous studies have confirmed that elderly fractures mainly occur in the thoracolumbar region, mostly due to osteoporosis combined with low-energy injury. The type of injury is mainly compression and rarely causes damage to the thoracolumbar spinal cord[19]. Therefore, burst fractures of the thoracolumbar spine caused by high energy damage are relatively rare in elderly patients.

In this study, multiple injuries were more common in the chest, but previous research has shown that the main multiple injury is a head injury, and the main cause of injury is traffic accidents[11, 20]. Our research also found that traffic accidents and high falls are most likely to cause chest injuries, and low falls are most likely to be combined with head injuries. The current results demonstrated that 27.8% (193 cases) of patients with TSCI experienced clinical complications, and the three main complications were respiratory system (51.3%), electrolyte disorder (25.9%) and venous thrombosis (21.8%). Respiratory complications such as pulmonary infections are the most common complication of TSCI. This finding has become a common consensus.

We found that 76.4% of patients underwent surgical treatment. The mainstream surgical approach is decompression, fixation and bone graft fusion. The posterior approach is more common. Patients with incomplete SCI were more likely to receive rehabilitation treatment than patients with complete SCI ( $P < 0.5$ ). There was no statistical difference in the length of hospital stay and the proportion of surgery between two groups.

In all of the patients included in this study, only 7 patients (1.0%) had in-hospital deaths, which was significantly lower than the US-reported average in-hospital mortality rate of 7.5% in 2010–2012[3]. We

conclude that the death data of this study are heavily influenced by traditional Chinese concepts. For example, for patients with severe TSCI who need to be maintained by a ventilator, family members who choose to give up treatment due to economic burden will maintain the patient's vital signs until they return home. Outcomes about the main causes of death, main causes of injury, and major injury levels for in-hospital died patients were the same as in previous studies[20–22].

## **Limitations**

There are some limitations in this study. The data are retrospective. Therefore, it is inevitable that there will be wrong information in the original case record, which will lead to deviation. We lost some information because many complications and treatments were not fully diagnosed or recorded in the medical records. This study was a hospital-based descriptive study about TSCI, which identified only a small part of all patients with TSCI in Shaanxi; thus, the overall incidence rate could not be calculated. In addition, the data of this study are limited, and the annual count of TSCI patients is not clear.

## **Conclusions**

The epidemiological characteristics of TSCI described in this study are somewhat different from those described in other countries. High falls and low falls were the two main causes, and the mean age of patients with TSCI was older than in other countries. The most frequent high-risk occupations reported in patients with TSCI were peasants and workers. Adult males are still a high-risk group for TSCI. All of these results prompted the conclusion that preventive approaches should be based on the characteristics of the different types of patients with TSCI and focused on high-risk groups.

## **Abbreviations**

Traumatic spinal cord injury (TSCI)

Spinal cord injury (SCI)

International Classification of Disease Version 10 (ICD-10)

American Spinal Injury Association (ASIA)

## **Declarations**

### **Funding**

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## Availability of data and materials

Please contact the corresponding author for data requests.

## Authors' contributions

All authors have read and approved the manuscript. All authors made substantial contributions to the design of the work or the acquisition, analysis, or interpretation of the data; AND participated in revising it critically; AND provided final approval of the version to be published; AND agree to be accountable for the work.

## Ethics approval and consent to participate

The protocol of this study was approved by the Institutional Review Board of Xi'an Honghui Hospital and waived the requirement to obtain patients' written informed consent.

## Consent for publication

All the patients agreed that we use their data for the study and publish our draft in the "Medical Science Monitor" journal. Retrospective design that waived the requirement to obtain patients' written informed consent.

## Competing interests

There was no commercial party related to this study and the authors declare that there is no competing interest.

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## Tables

**Table 1.** Characteristics of Patients With TSCI

	TSCI with spinal fracture (n=518)	TSCI without spinal fracture (n=176)	Total (n=694)
<b>Sex</b>			
Male	393 (56.6)	145 (20.9)	538 (77.5)
Female	125 (18.0)	31 (4.5)	156 (22.5)
<b>Age, years</b>			
≤15	3 (0.4)	5 (0.7)	8 (1.2)
16-25	38 (5.5)	2 (0.3)	40 (5.8)
26-35	84 (12.1)	13 (1.9)	97 (14.0)
36-45	116 (16.7)	26 (3.7)	142 (20.5)
46-55	128 (18.4)	50 (7.2)	178 (25.6)
56-65	93 (13.4)	45 (6.5)	138 (19.9)
66-75	48 (6.9)	31 (4.5)	79 (11.4)
≥76	8 (1.2)	4 (0.6)	12 (1.7)
<b>Occupation</b>			
Civil servants	2 (0.3)	2 (0.3)	4 (0.6)
Professional technicians	7 (1.0)	2 (0.3)	9 (1.3)
Enterprise staff	20 (2.9)	5 (0.7)	25 (3.6)
Workers	59 (8.5)	14 (2.0)	73 (10.5)
Peasants	313 (45.1)	108 (15.6)	421 (60.7)
Students	12 (1.7)	5 (0.7)	17 (2.4)
Freelances	13 (1.9)	3 (0.4)	16 (2.3)
Self-employed	1 (0.1)	2 (0.3)	3 (0.4)
Unemployed	5 (0.7)	1 (0.1)	6 (0.9)
Retired	18 (2.6)	14 (2.0)	32 (4.6)
Other	68 (9.8)	20 (2.9)	88 (12.7)
<b>Medical insurance</b>			

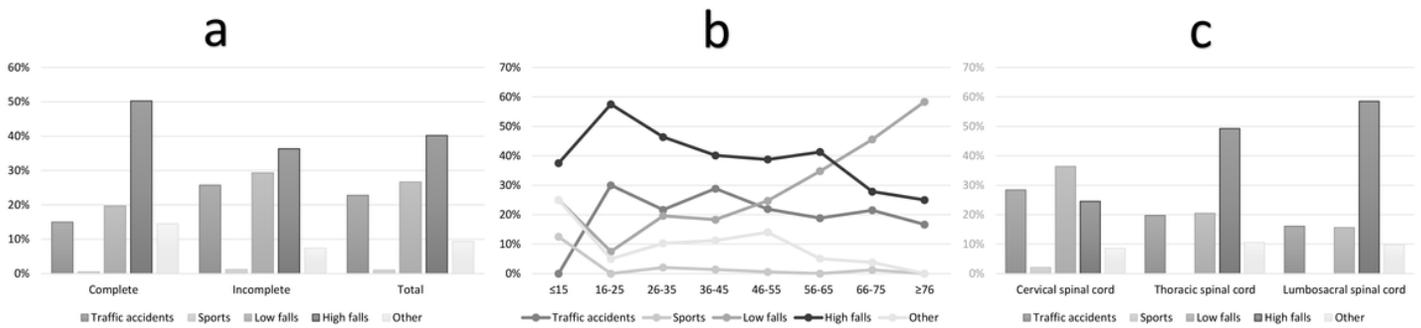
None	235 (33.9)	60 (8.6)	295 (42.5)
Rural cooperative medical care	190 (27.4)	74 (10.7)	264 (38.0)
Urban Residents Basic Health Insurance	22 (3.2)	7 (1.0)	29 (4.2)
Urban employees basic medical insurance	16 (2.3)	11 (1.6)	27 (3.9)
Commercial insurance	2 (0.3)	1 (0.1)	3 (0.4)
Other	53 (7.6)	23 (3.3)	76 (11.0)
<b>Cause of injury</b>			
Traffic accidents	107 (15.4)	51 (7.3)	158 (22.8)
Sports	4 (0.6)	3 (0.4)	7 (1.0)
Low falls	113 (16.3)	72 (10.4)	185 (26.7)
High falls	246 (35.4)	33 (4.8)	279 (40.2)
Other	48 (6.9)	17 (2.4)	65 (9.4)
<b>Injury level</b>			
Cervical spinal cord	182 (26.2)	156 (22.5)	338 (48.7)
Thoracic spinal cord	117 (16.9)	15 (2.2)	132 (19.0)
Lumbosacral spinal cord	219 (31.6)	5 (0.7)	224 (32.3)
<b>ASIA Grade</b>			
A	155 (22.3)	31 (4.5)	186 (26.8)
B	58 (8.4)	20 (2.9)	78 (11.2)
C	107 (15.4)	61 (8.8)	168 (24.2)
D	198 (28.5)	64 (9.2)	262 (37.8)

ASIA: American Spinal Injury Association

**Table 2.** Treatment Options Followed by Patients With TSCI by the Severity of the Injury

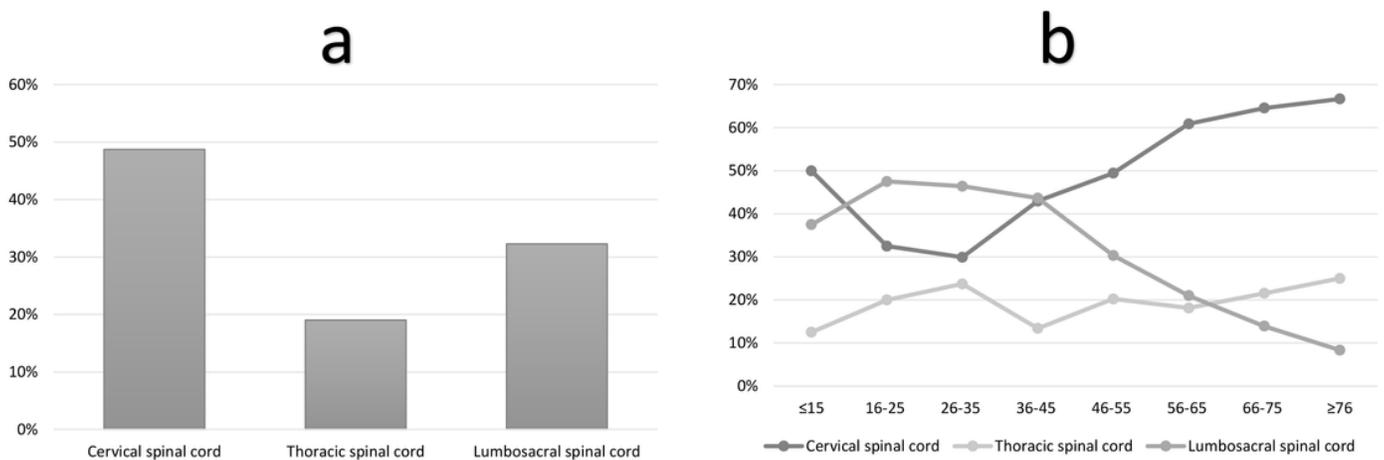
Treatment	Severity of Injury, n (%)		
	Complete	Incomplete	Total
Conservative	46 (6.6)	118 (17.0)	164 (23.6)
Surgery	147 (21.2)	383 (55.2)	530 (76.4)
<b>Surgical Procedures</b>			
Simple spinal cord decompression	2 (0.4)	5 (0.9)	7 (1.3)
Decompression and fixation	15 (2.8)	53 (10.0)	68 (12.8)
Decompression, fixation and fusion	123 (23.2)	300 (56.6)	423 (79.8)
Other	7 (1.3)	25 (1.3)	32 (6.0)
<b>Surgical approach</b>			
Anterior	16 (3.0)	101 (19.1)	117 (22.1)
Posterior	124 (23.4)	266 (50.2)	390 (73.6)
Combination of Anterior and Posterior	6 (1.1)	14 (2.6)	20 (3.8)
Other	1 (0.2)	2 (0.4)	3 (0.6)
<b>Rehabilitation</b>	75 (10.8)	248 (35.7)	323 (46.5)
<b>Length of hospital stay</b>	18.7±15.8	17.6±17.7	17.9±17.2

## Figures



**Figure 1**

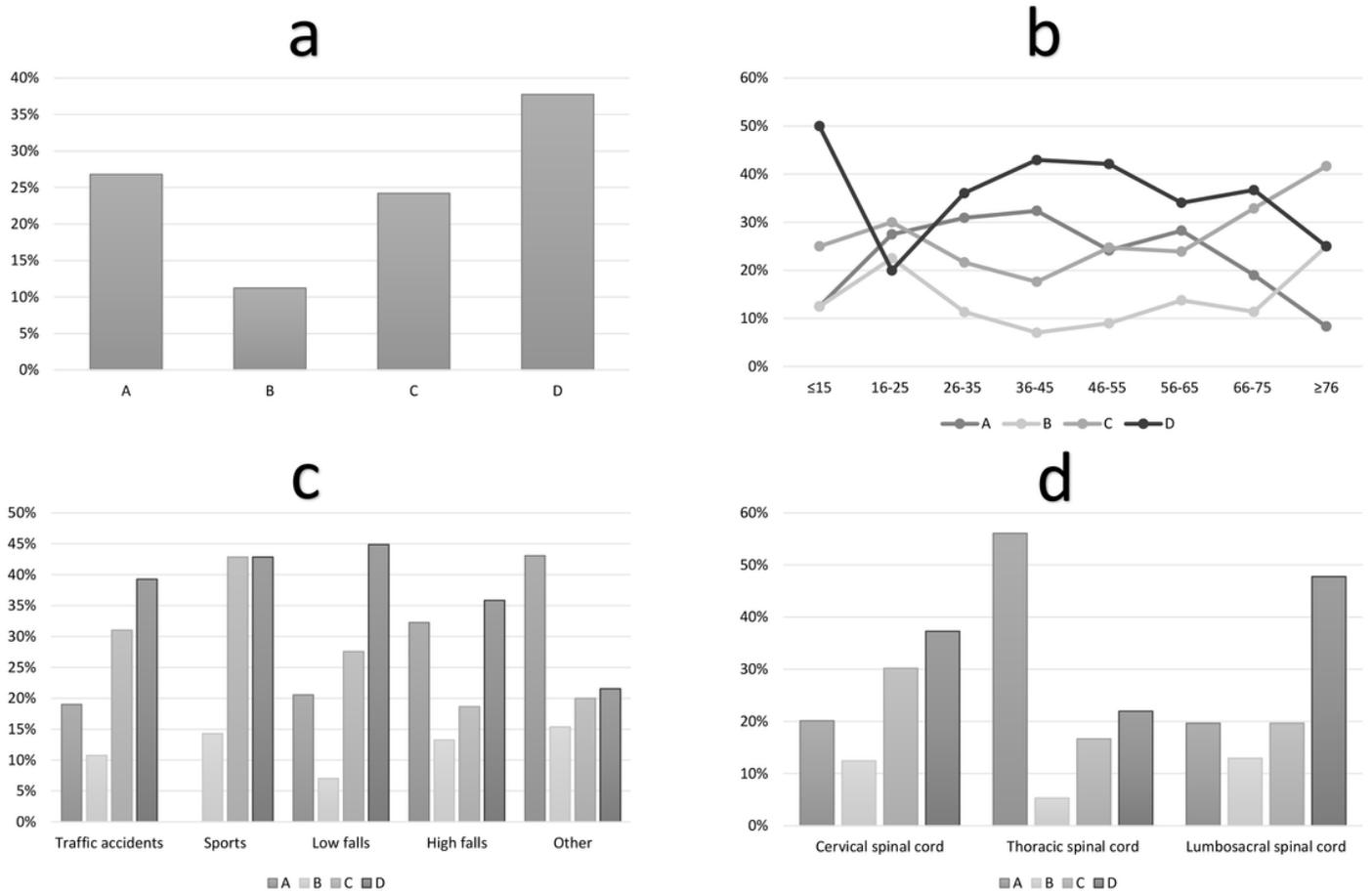
As shown in Figure 1a, the leading causes of TSCI in Shaanxi are high falls (40.2%), and the other two important causes are traffic accidents (22.8%) and low falls (26.7%). Observing the distribution of the cause of injury (Figure 1b), we found that in the 16-25 age group, the highest cause was high falls (57.5%), which tended to decrease with increased age. The proportion in the  $\geq 76$  age group reached 25.0%. The proportion of low falls in the 16-25 age group was 7.5%, and they increased with age and reached 58.3% ( $\geq 76$  age group). The leading cause of injury in the level of cervical spinal cord was low falls (36.4%), in the level of thoracic spinal cord and lumbosacral spinal cord was high falls (49.2%, 58.5%), respectively (Figure 1c).



**Figure 2**

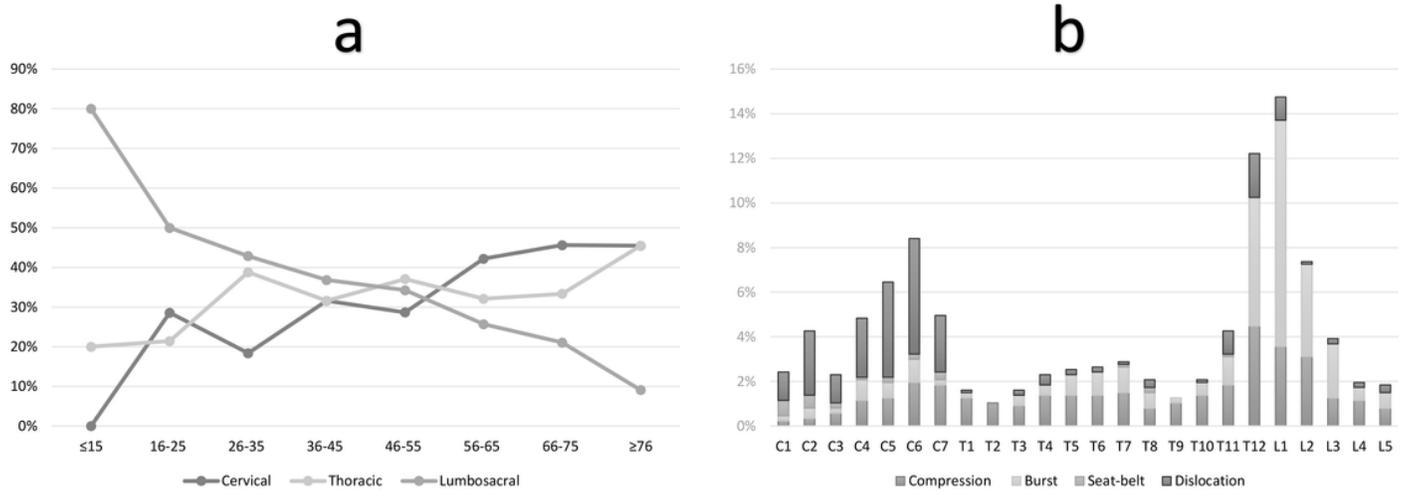
The most common injury that patients with TSCI suffered was a cervical injury (338 cases), which accounted for 48.7% of all cases, followed by thoracic and lumbar injuries (132 and 224 cases, respectively) (Figure. 2a). There was a tendency for cervical SCI to increase with age, and the proportion

in the  $\geq 76$  age group (66.7%) was the highest. The proportions of lumbosacral SCI decreased with increasing age and were only 8.3% in the  $\geq 76$  age group (Figure 2b).



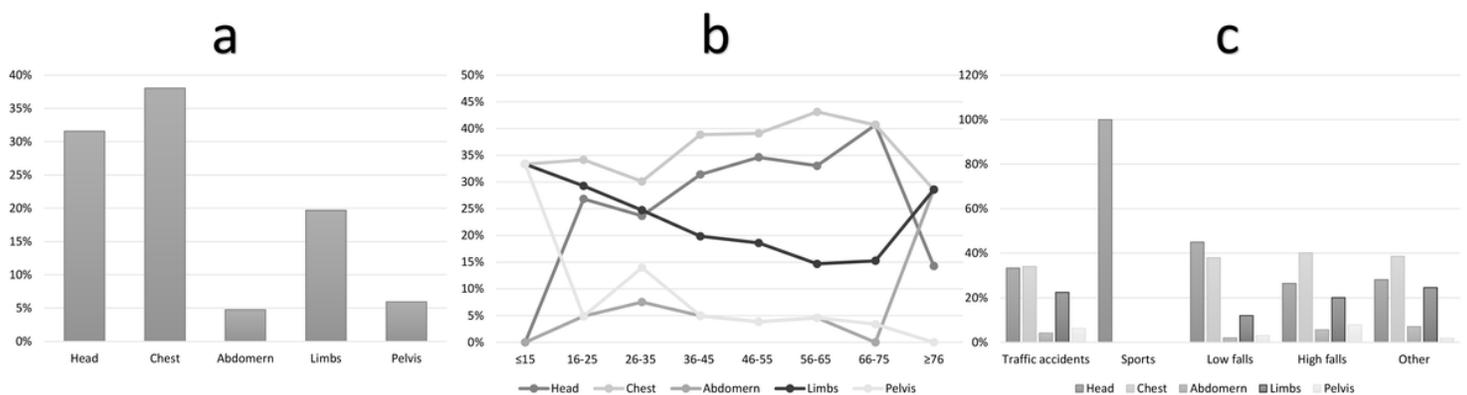
**Figure 3**

The highest proportion of severity of injury in the included TSCI patients was incomplete quadriplegia (38.5%), followed by incomplete paraplegia (33.7%). The ASIA (American Spinal Injury Association) grade was used to quantify the severity of injury, with the highest proportion being ASIA Grade D (37.8%), followed by ASIA Grade A (26.8%) (Figure 3a). However, four grades did not show a clear trend with age (Figure 3b). In addition, the leading ASIA Grade in patients with major causes such as traffic injuries, low falls and high falls are Grade D (36.2%, 44.9%, 35.9%, respectively) (Figure 3c). The distribution of ASIA grade in different injury level was also different. the leading ASIA Grade in patients with cervical spinal cord and lumbosacral spinal cord were Grade D (37.3%, 47.8%, respectively). However, in patients with thoracic spinal cord was Grade A (56.1%) (Figure 3d).



**Figure 4**

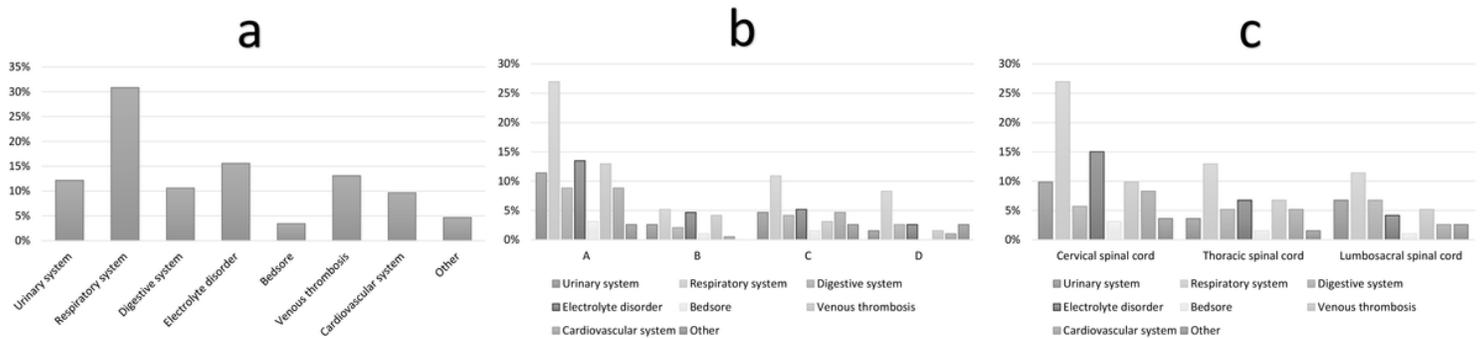
The proportion of TSCI combined with cervical and thoracic vertebrae fractures in all age groups gradually increased with age, up to 45.5%, 45.5%, respectively ( $\geq 76$  age group), while the proportion of lumbosacral vertebrae fractures gradually decreased with increasing age, with the lowest at 9.1% ( $\geq 76$  age group) (Figure 4a). In the cervical spine, the C5 (6.5%) and C6 (8.4%) vertebral bodies were more commonly combined with fractures, and the major fracture type was dislocation. T12 (12.2%) has the high proportion of fractures in the thoracic spine, and burst fractures are main fracture type. In the lumbar spine, L1 (14.8%) and L2 (7.4%) were easily combined with fractures, and the fracture type was mainly burst (Figure 4b).



**Figure 5**

With regard to combined multiple injuries, the chest (38.0%) accounted for the highest proportion of all TSCI patients, followed by the head (31.6%) and limbs (19.7%) (Figure 5a). Except insufficient data in  $\geq 76$  age group, the distribution of multiple head and chest injuries in rest age groups showed a trend of

increasing with age, up to 40.7% (66-75 age group), 43.1% (56-65 age group), respectively. Multiple limb and pelvic injuries showed a tendency to decrease with increasing age (Figure 5b). The distribution of multiple injuries in different cause of injury was also different. The leading multiple injuries in patients caused by traffic accidents and high falls are chest (34.0%, 40.1%, respectively). However, in patients caused by low falls is head (45.0%) (Figure 5c).



**Figure 6**

27.8% (193 cases) of patients with TSCI experienced clinical complications, in which, 51.3% had respiratory complications, followed by electrolyte disorder (25.9%) and venous thrombosis (21.8%) (Figure 6a). The main clinical complication is still respiratory system, even in different ASIA grades or injury level (Figure 6b-c).

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementarymaterialsRawdata.pdf](#)