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Original Article

Hospital-Based Incidence of Traumatic Spinal Cord Injury in Tehran, Iran

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Abstract

Background: The goal of this study was to describe the hospital-based incidence of traumatic spinal cord injury in Tehran, Iran.

Methods: We retrospectively reviewed the hospital records of traumatic spinal cord injury patients, admitted between March 2010 and July 2011 in 61/68 hospitals of Tehran.

Results: Overall, 138 cases of traumatic spinal cord injury were identified. The majority of patients were male (84.8%). The mean age was 33.2 ± 14.3 years. 54.3% patients were residing in Tehran and the others were referred from other cities. The mean annual incidence of hospitalized traumatic spinal cord injury patients of Tehran was 10.5/1,000,000/year (95% confidence interval: 9-12). Fall was the leading cause of injury (45.7%), followed by road traffic crash (40.6%). The most common cause of tetraplegia (cervical traumatic spinal cord injury) was road traffic crash. The duration of hospital stay for tetraplegia and paraplegia (thoracic and lumbar traumatic spinal cord injury) was 22.7±23.7 and 12.5±7.5, respectively (P<0.001). Early surgery (surgical decompression within 24 h) was done for 19% of the patients. The median day of hospitalization for early and late surgery was 7.5 and 12, respectively (P=0.044).

Conclusion: Preventing traumatic spinal cord injury should focus on males, age group of 21-30 years, falls and road traffic crash. More studies are suggested to evaluate the incidence of non-hospitalized traumatic spinal cord injury patients.

Keywords: Incidence, Spinal cord injury, Trauma, Iran

Introduction

Traumatic spinal cord injury (TSCI) can leadto varying degrees of motor, sensory, and/orautonomic deficits (1, 2). TSCI causes high mortality, severe disability, expensive cure, extensive rehabilitation, and a high economic burden (3-5). Since there has been no definite treatment for TSCI, prevention efforts are important. Therefore, it is necessary to determine the epidemiological features, causes and circumstances that result in injury for developing preventive strategies (6). Currently, just few studies have reported the epidemiology of TSCI in Iran (7). We do not know how many people with SCI are living in Iran. In the first published population-based study from Iran, the prevalence of traumatic SCI in Tehran was 4.4 per 10,000 people (8). But no hospital-based study has been done to indicate the incidence of SCI in Tehran, yet. Because of the high incidence of severe injuries in Iran (9), epidemiologic data concerning causes of TSCI, associated

risk factors, clinical consequences and costs are vital for planning preventive and therapeutic programs to reduce this health dilemma.

The following research presents the results of a hospital-based study from Tehran, the capital of Iran. The study population includes people who were hospitalized for TSCI from March 21, 2010 to July 22, 2011. The goal of this research was to describe the hospital-based incidence of traumatic SCI in Tehran for which data are available.

Materials and Methods

This retrospective hospital-based study was performed in governmental, private, and military hospitals of Tehran which had a neurosurgery department, during 16 months (March 21, 2010 to July 22, 2011). Given the ministry of health website (http://avab.behdasht.gov.ir/hospital/), appropriate hospitals were selected. After coordination with vice - chancellors in treatment affairs of five Tehran universities of medical sciences (Artesh, Baghiatollah, Shahed, Shahid-Beheshti, and Tehran), as main regulators of hospitals, this research started.

Among 68 hospitals of Tehran which had a neurosurgery department, 61 were studied. Three private and two military hospitals did not allow surveying their data. Computerized medical record systems of two governmental hospitals were corrupted. In the Medical Records Departments of hospitals, patients' files with the diagnosis of "TSCI" were surveyed. To prevent data missing, besides "TSCI", patients with the diagnosis of "traumatic fracture or dislocation of spine" were investigated, too.

The first author (MS) studied all available records and documented the general demographic characteristics of the patients (name, gender, age, marital status, profession, nationality, residential location address, phone,etc.), cause of injury, season, level of spinal injury, associated injuries, AIS on admission and discharge, timing of surgery, duration of hospital stay, final outcome, and the hospital costs that was paid by the patients in a designed and specific questionnaire. To ensure the accuracy of the information, 15% patients were contacted, randomly.

The falls were divided into two groups according to height: less than 6 meters (m) as low height falls, and at least 6 m as high ones (10, 11). Surgical decompression within 24 h and after that was considered early and late surgery, respectively.

After data entering, patients who had hospitalized in more than one hospital were matched. Before the data was processed, all data was rechecked to minimize data entry errors and missing data.

The overall incidence was calculated based on the patients who lived in Tehran and were injured between March 21, 2010 and March 20, 2011 (the Persian calendar year).Population of Tehran was considered 7,976,000 which have been determined by the Statistical Center of Iran in 2006.

Descriptive summaries were conducted using PASW (SPSS Inc., Illinois, USA). Descriptive statistics are reported using proportions and means for the categorical and continuous data, respectively and a *P* value less than 0.05 was considered significant. The proportions and relationships most relevant to the emerging patterns in TSCI and to clinically important factors were examined for strengths of association using chi-square tests.

Results

Of 867 patients with spine fracture, 621 (71.6%) were male. Two most common mechanisms of the vertebral fracture were fall with 393 cases (45.3%) and road traffic crash (RTC) with 228 cases (26.3%). Figure 1 shows the distribution of these mechanisms based on sex and age of the patients. Vertebral fracture was more prevalent in the following seasons, respectively: summer, spring, autumn and winter. The above-mentioned prevalence was seen in both causes of fall and RTC. However, fall was more prevalent in winter and RTC was more prevalent in spring. L1 was the most common site of fracture, accounting for 22.7% of all fractures, and T12 fractures as the second most common vertebra were seen in 12.9% of the patients. The number of vertebral fractures in fall and RTC has been shown in Fig.2. Figure 2 and 3, allowing the comparison of the

distribution of vertebral fracture between fall and RTC. Of 867 patients with spine fracture who survived to hospital admission, 138 (15.9%) had TSCI (Table 1). The majority of TSCI patients were male (84.8%). Their mean age was 33.2 ± 14.3 years. 63 cases (16%) of 393 vertebral fractures due to fall and 56 cases (24.6%) of 228 vertebral fractures due to RTC led to TSCI. Namely, RTC had more TSCI than fall (P<0.001). 54.3% patients were residing in Tehran and the others were referred from other cities. 16 patients (11.6%) had foreign nationality. Therefore, the mean annual incidence of hospitalized TSCI patients of Tehran was 10.5 per million populations per Year (95% Confidence Interval (CI): 9-12). 77% of TSCI patients had single vertebral fracture, whereas double, triple, quadruple and non-accessible ones were 18, 4, 0.3 and 0.7%, respectively. The distribution of vertebral fracture in TSCI patients has been shown in figure 4. The most common level of injury was at thoracic segments (49.6%), particularly T12 (18.1%), and lumbar segments (27.6%), in particular L1 (14.9%).

The number of vertebral fractures in fall and RTC among TSCI patients has been shown in figure 3. Lesions in Individuals with TSCI caused by fall are mostly located in lower thoracic and lumbar levels. Injury due to RTC caused lesions mainly at cervical, middle and lower thoracic and lumbar levels. The mean height of fall was 7.7±4.2 meters. Among 240 falls from low height and 153 ones from high height, 23 and 40 cases led to TSCI, respectively (P<0.001). The mean age of low fall cases was 41.3±16 years, whereas the mean age of high fall cases was 29.3±10.7 years (P=0.018). The majority of cases presented with paraplegia (61.9%). The number of tetra or para plegic/paretic patients due to different causes is shown in the Table 2. Fall was more common than RTC (P=0.047). Admission AIS for 119 patients (86.2%) was A, whereas, 3.6, 2.2, and 8% had AIS B, C, and D, likewise. No change in neurologic deficit was seen in 119 patients (86.2%). However, 7 patients (5.8%) improved at least one AIS grade. During hospitalization, 11 patients (8%) deceased (except emergency department deaths) and all were men. Six patients, with the mean age of 38±20 years had RTC injuries. Three patients (mean age=52±8 years) had been injured due to high height fall. The other two were injured by other causes. Among dead cases, 6 persons had cervical injuries with complete tetraplegia and 5 others had thoracic injuries with complete paraplegia (OR=3.2, CI=0.9-11.5). The time of death in these patients ranged from 1 to 77 days (median = 14, interquartile range = 11–19 days).

Early and late surgery was done for 19% and 81% of the patients, respectively. The mean duration of hospital stay for all SCI patients was 14.2±11.9 days. The median day of hospitalization was 12, but for early and late surgery, it was 7.5 and 12, respectively (P=0.044). The duration of hospital stay for tetra-plegic/paretic patients was 22.7±23.7 days, but for para-plegic/paretic patients, it was 12.5±7.5 (P<0.001).

The number of TSCI patients and their hospital costs based on the cause of injury and type of hospital has been presented in Table 3. Of 138 patients, 46 (33.3%) TSCI patients were hospitalized in private hospitals which significantly paid more than other patients (P=0.001).

Table 1: Demographics of patients with vertebral fracture in Tehran, Iran, March 21, 2010 to July 22, 2011 (N=867)

Cause	TSCI			Not TSCI			Total		
	Male n (%)	Female n (%)	Total n (%)	Male n (%)	Female n (%)	Total n (%)	Male n (%)	Female n (%)	Total n (%)
Fall	57(48.7)	6(28.6)	63(45.7)	218(43.3)	112(49.8)	330(45.3)	275(44.3)	118(48)	393(45.3)
RTC	44(37.6)	12(57.1)	56(40.6)	121(24)	52(23.1)	173(23.7)	165(26.6)	64(26)	229(26.4)
Others	16(13.7)	3(14.3)	19(13.8)	165(32.7)	61(27.1)	226(31)	181(29.1)	64(26)	245(28.3)
Total	117(84.8)	21(15.2)	138(15.9)	504(69.1)	225(30.9)	729(84.1)	621(71.6)	246(28.4)	867(100)

TSCI: Traumatic Spinal Cord Injury

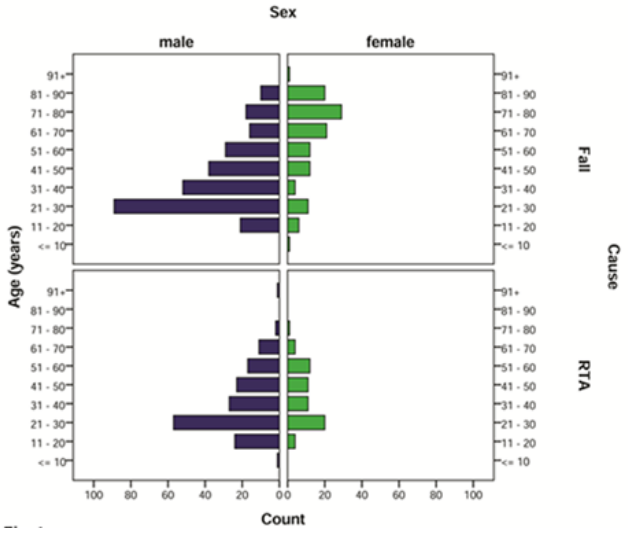

Fig.1: Number of patients with vertebral fracture by age, sex and two common causes in Tehran, Iran, March 21, 2010 to July 22, 2011

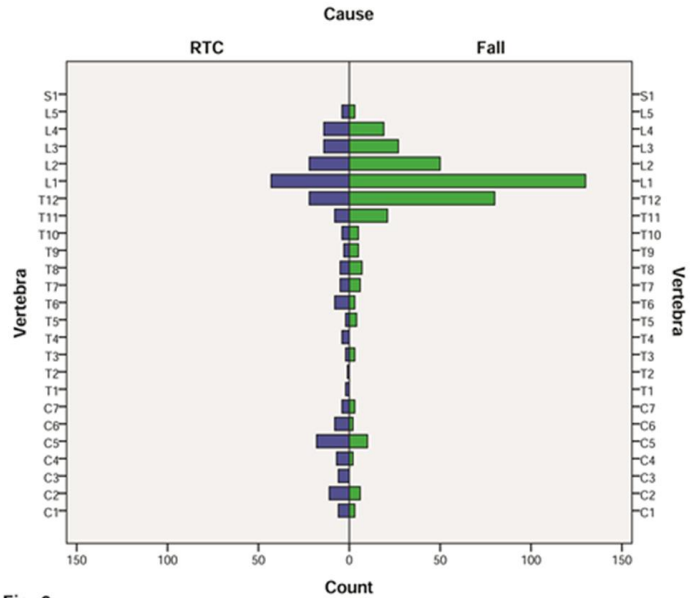

Fig. 2: Number of fractured vertebrae due to Road Traffic Crash (RTC) and fall in Tehran, Iran, March 21, 2010 to July 22, 2011

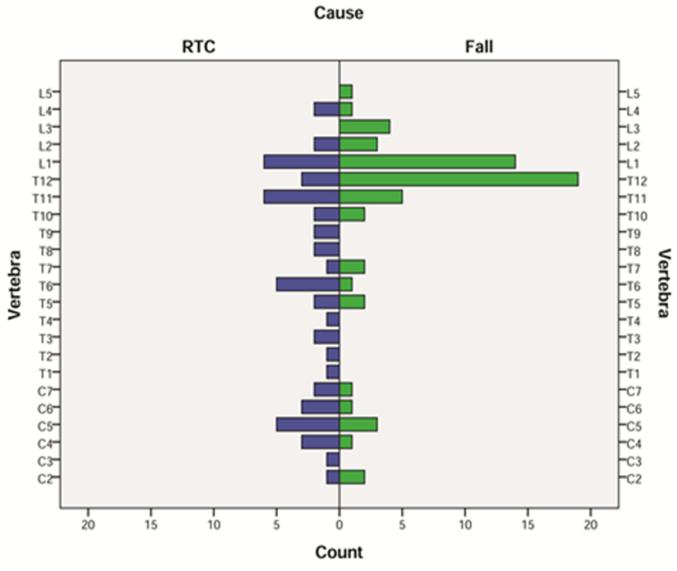

Fig.3: Number of fractured vertebrae due to Road Traffic Crash (RTC) and fall among traumatic Spinal Cord Injury (SCI) patients in Tehran, Iran, March 21, 2010 to July 22, 2011

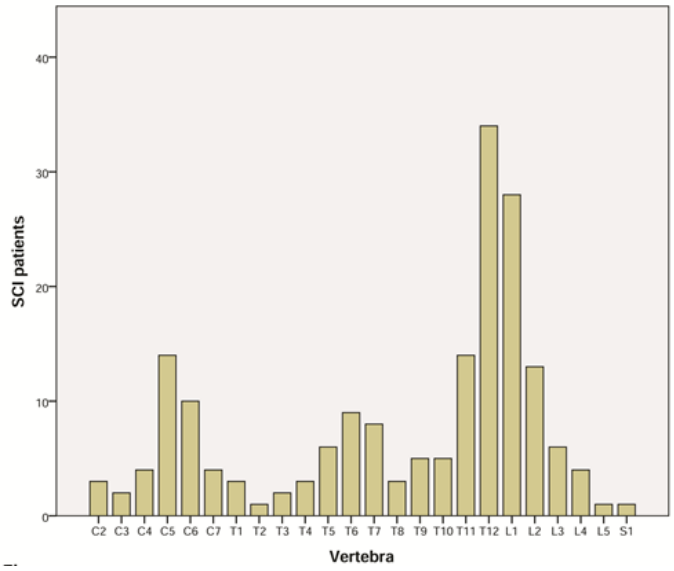

Fig. 4: Number of fractured vertebrae in traumatic Spinal Cord Injury (SCI) patients in Tehran, Iran, March 21, 2010 to July 22, 2011 (N=138)

Table 2: Plegia/Paresis in Traumatic Spinal Cord Injury patients by cause in Tehran, Iran, March 21, 2010 to July 22, 2011 (N=138)

Cause	Plegia/Paresis		
	Para	Tetra	Total
	n (%)	n (%)	n (%)
Fall	56 (88.9)	7 (11.1)	63 (45.7)
RTC	42 (75)	14 (25)	56 (40.6)
Others	15 (79)	4 (21)	19 (13.8)
Total	113 (81.9)	25 (18.1)	138 (100)

RTC: Road Traffic Crash

Table 3: Hospital type, cost and Traumatic Spinal Cord Injury patients by cause in Tehran, Iran, March 21, 2010 to July 22, 2011 (n=138)

Cause	Hospital Type							
	Governmental		Military		Private		Total	
	n (%)	Cost*	n (%)	Cost*	n (%)	Cost*	n (%)	Cost
		Mean±SD		Mean±SD		Mean±SD		Mean±SD
Fall	38 (44.7)	5.2±3.3	2 (28.6)	2.8±4.2	23 (50)	8.1±7.1	63 (45.7)	6.4±5.5
RTC	37 (43.5)	5.7±3.3	3 (42.8)	10.7±8.9	16 (34.8)	10.4±7.1	56 (40.6)	7.9±5.6
Others	10 (11.8)	4.1±1.6	2 (28.6)	7.3±7.1	7 (15.2)	8.5±2.6	19 (13.8)	6.8±3.5
Total	85 (61.6)	5.3±1.3	7 (5.1)	7.6±6.9	46 (33.3)	9±6.6**	138 (100)	7±5.4

* 10,000,000 Iranian Rials is equal to 400 USD.
** Private hospital fees were significantly higher (*P*=0.001).

Discussion

The aim of this investigation was to describe the hospital-based incidence of TSCI in Tehran. The mean annual incidence of hospitalized SCI patients of Tehran was 10.5 per million populations per year (95% CI: 9-12). A population-based study in Tehran showed an estimated annual incidence rate of 72.45 new cases of SCI per 1,000,000 people (7). These differences may be associated with population or geographic specifications or possibly related to the methods of conducting the survey. On the other hand, a hospital-based study may underestimate the incidence rate of a health problem in comparison to a population-based study. In our study, TSCI patients who died at the scene of injury or were discharged from the emergency department (without hospitalization or operation due to poverty) have not been included because of the absence of a data registration system. In some hospitals, patients' records had been lost.

A hospital-based study from Kashan (a city in the center of Iran) estimated an incidence rate of 30 cases per 1,000,000 people (12). To calculate the incidence, we considered just individuals with TSCI living in Tehran, regardless of the referral patients from other cities. There are higher reported values (18.8/1,000,000 population/year) from Taiwan (13) or (30/1,000,000 population/year) from Iceland (14). Due to the absence of autopsy, we missed those who might have had SCI at the time of death at the scene. A similar study in the US in 1994 reported that the incidence of hospitalized TSCI patients was 25 per million per year and RTC was accounted for

about 70% of all (15). Meanwhile, the rate of serious injuries due to RTC has decreased in developed countries (16).

Patterns of spinal fractures are similar to other studies (17-19). In this study, 15.9% of the patients with spine fracture had SCI. Neurologic injury occurred in 12.9% of the patients with spine fracture (19). Heidari et al. extracted from the Iranian national trauma registry database that among patients with traumatic spinal fracture, there was 5.6% SCI from 1999 to 2004 (20). This disparity may be due to an increase in the severity of injuries.

Similar to other studies, the incidence rates for males were higher than females in all age groups (3, 21-25). TSCI is more common in the age group of 21-30 years. This is in agreement with previous reports from Iran (7, 8, 26). Based on our study and the others, there was an increasing incidence of SCI in elderly women (21, 27, 28). It can be related to the effects of menopause on estrogen-mediated neuroprotection (29).

Fall was the most common cause of TSCI in Tehran. Two studies from China showed a high occurrence of falls, too (25, 30). Falls were the most common leading cause in developing countries, whereas traffic accidents were the most frequent ones in developed countries (31, 32). In Southern Asia and Oceania, fall from rooftops and trees is the major cause (32). In a meta-analysis in developing countries, fall and RTC consisted 34.9 and 41.4% of the causes of TSCI, respectively (33). There are crowded traffic jams in roads of Tehran, whereas severity of injuries is greater when traffic is hourly light (34). On the other hand, severe injuries including RTCs which lead to pre-hospital deaths were not considered in our study. According to other studies, fall is more frequent in elderly people (21, 22). In our study, high height falls were more associated with TSCI than low height falls. It could be due to the presence of a lot of construction workers and well diggers in Tehran who are generally young with a high incidence of injury (35). The most common cause of occupational SCI was falls (36, 37).

In the present study, the most common level of injury in TSCI patients was at thoracic segments. It is similar to another study from Iran (38), whereas in developed countries, in general, the cervical part is the most common one (21, 22, 39). Rapid external immobilization is vital in case of cervical fractures in the scene of accident (18). Nevertheless, due to limited resources and crowded streets, Iran Emergency Medical Services (EMS) could transfer just one third of the patients entering Emergency Departments (ED) and most injured people are carried to ED without considering the principles of patient movement and transfer (40, 41). Also, some of these patients pass away in the scene of accident. Dryden et al. asserted that persons who died prior to hospitalization were more likely to have been injured at the cervical level (21).

Lumbar spine fractures were more frequently seen in falls, while cervical ones were more commonly seen in RTC, and thoracic ones had a similar frequency in both mechanisms (42). When someone falls from a height, s/he more likely falls on the back or shoulders, and this force is conducted downward to the thoraco-lumbar junction (39). The severity of injury differed between falls from high and low heights significantly (11, 17, 42).

The majority of cases presented with paraplegia. This dominance was shown in other studies (22, 30, 43, 44). A literature survey showed that two-thirds of TSCI patients are paraplegic (4). Also, the increase in percentage of tetraplegic and complete lesions was shown in accessible studies (4). The most common cause of tetraplegia is RTC (45) which was shown in our study. Complete injuries, more often, were due to RTC (39). But a study based on the Australian Spinal Cord Injury Registry showed notably declining rates in RTC related injury and complete tetraplegia, increasing rates in fall related injury, incomplete tetraplegia and complete paraplegia (46).

In our study, 86.2% of TSCI were complete. In developing countries, complete TSCI is more common than the incomplete (33). Burn et al. reported AIS A in 78.7% of SCI patients (47). Geisler (48), Marino (49), and Kirshblum et al. (50) reported that complete cases were 63%, 60%, and 58%, respectively.The high percentage of the pa-

tients with AIS A was associated with the severity of injuries.

In our study, during hospital stay, neurological improvement was observed in 5.8% of the TSCI patients with incomplete SCI, and damage in thoraco-lumbar level. Older individuals had a significantly greater proportion of incomplete SCI compared with younger individuals (51). Whereas some studies showed that younger patients had better neurological outcomes (52, 53), others believed in no significant correlations between age and recovery after SCI (51, 54). Incomplete SCI carried a better prognosis of motor improvement (54). The effects of severity, type, and level of injury or surgery performed in the first 24 hours on the outcome are still challenging (51-57). In our study, patients with the diagnosis of "traumatic fracture or dislocation of spine" were included to prevent data missing. Meanwhile, some studies reported some SCIs without the evidence of vertebral fracture or dislocation (58, 59). They emphasized that the analysis of age, mode of injury, vertebral degeneration, spinal stenosis and other factors would contribute to identify the causality between the injury and the outcome in these cases (58, 59).

In-hospital mortality was 8% in our study. Prior studies have mostly reported long-term mortality following SCI (60, 61). It was 8% and 5.7% in Pickett (18) and Furlan et al. (62) studies, respectively. Hospital mortality was 17% in patients with multiple injuries having a significantly higher mortality rate than patients with isolated SCI (63). Similar to our study, mortality among the elderly patients was generally due to falls (39, 64), but RTC more often affected the youth and was associated with a higher degree of injuries and mortality (20). In our study during hospital stay, 50% of the deaths occurred within 14 days. Older age, relevant pre-existing medical conditions, and complete SCI were major risk factors for in-hospital death after acute SCI (62, 65, 66). Cardiorespiratory complications are a major cause of death in the early hospital period (1, 67).In our study, 6 persons who had cervical injuries with complete tetraplegia died. Cervical injuries were associated with early death more often than thoracic fractures (OR=3.2, CI=0.9-11.5). 1.9% of the causes of RTC-related deaths in Tehran were cervical SCI (68).

In our study, the duration of hospitalization was higher among the tetraplegic patients and RTC injuries. Tugcu et al. reported that hospital stay in TSCI patients due to RTC was 80.9±53.4 days and significantly higher than the other cases (44). In contrast, early surgery significantly decreased the length of hospital stay, as other studies reported that intervention of TSCI earlier than 24 hours was associated with shorter length of hospitalization (69, 70).

The mean hospital direct cost that was paid by each TSCI patient was 2800±2160 United States Dollar (USD). In the US, TSCI leads to the highest amount of direct hospital costs of trauma (71) and imposes a considerable burden on patients, their families, and society, because of expenses for treatments and lost productivity (72).

On the other hand, based on an approved national policy, all medical services, including governmental or private ones, are free-of-charge for RTC victims (73). But our study showed that each RTC patient paid averagely 3160±2240 USD. This could be related to the weak law enforcement or law breaking in the hospitals.

Many TSCI patients (45.7%) had been referred from other cities to Tehran. This indicates lack of medical facilities in other cities that must be considered.

Due to lack of data registration system, inaccessibility to the information of some hospitals, and patient transmission from other cities, we were not able to evaluate the exact incidence of SCI in Tehran.

Because of the absence of a data registration system, patients who died at the scene of injury or were discharged from the emergency department have not been included. This leads to underestimating the importance of the problem and missing the main causes of TSCI.

Also, costs were considered regardless of the contribution of insurance companies, therefore the real cost would be much higher.

Conclusion

The data from this study suggests that the strongest efforts in preventing SCI should focus on males, individuals between the ages of 21 and 30 years, falls and RTC. Further studies are suggested to evaluate the incidence of non-hospitalized SCI patients and follow the long-term outcome of SCI.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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