ORIGINAL ARTICLE

Demographic profile of traumatic spinal cord injuries admitted at Indian Spinal Injuries Centre with special emphasis on mode of injury: a retrospective study

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Objectives: To identify the demographic profile of persons with traumatic spinal cord injury (TSCI) admitted at the center.

Setting: Indian Spinal Injuries Centre.

Study design: Retrospective analysis.

Methods: Information was collected in 2010 from case sheets of 1138 persons with TSCI admitted from January 2002 to May 2010. A telephonic survey was conducted to get further insight into fall from height (FFH) or road traffic accident (RTA) as a mode of injury.

Results: The mean, median and mode for the age were 34.4, 32 and 30 years, respectively. Male:female ratio was 5.9:1 and 63.18% ($n=719$) were married. RTA was the most common (45%) and FFH the second most common (39.63%) mode of injury. Overall, 66.67% suffered from paraplegia and 71.18% had complete injuries.

Conclusion: As compared to other Indian published studies, our study had a much larger number of persons with TSCI and could be considered as the most representative amongst available literature for the Indian population. The study suggests that the demographics of spinal injury in India differs significantly from that in the developed countries since there was a lower mean age, much larger number of males, married individuals, injuries due to two wheeler accidents/falls, paraplegics and complete injuries. In contrast to other published Indian pilot studies, RTA was the most common mode of injury. Our study brings out the need for a proper epidemiological study and for establishing services for pre-hospital and acute care.

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Keywords: demographics; spinal cord injury; epidemiological differences; Indian; mode of injury

INTRODUCTION

The importance of epidemiological studies in planning prevention strategies as well as clinical and community services for persons with spinal cord injury (SCI) is well established.^{1,2} They provide a baseline to monitor the effectiveness of interventions.¹ They help in prioritization for resource allocation and thus should be especially helpful for developing countries, which have limited resources.

Epidemiology of a particular ailment is linked to social, environmental, cultural and biological issues and thus varies from region to region.³ However, despite its importance, there are hardly any proper epidemiological studies from developing countries. Because of the inherent difficulties in carrying out epidemiological studies, experts in countries like India resort to demographic studies for information. However, there are only a few hospital-based Indian pilot demographic studies^{4–8} and information from these too has varied depending on the region and the rural or urban population catered by the hospital.

The current study was undertaken to study the demographic profile of persons with SCI treated at Indian Spinal Injuries Centre (ISIC), recognized as the tertiary center for spinal injuries by the Indian government.

MATERIAL AND METHODS

After clearance from Institutional Ethics Committee, records of all new admissions of persons with traumatic SCI (TSCI) at ISIC from January 2002 to May 2010 were reviewed in 2010. Information was collected by the authors from 1138 case sheets.

Geographical location (state-wise distribution), rural–urban distribution, age, gender, marital status, educational level, vocational status, day and month of injury, mode of injury, type of injury, vertebral and neurological level and American Spinal Injury Association (ASIA) Impairment Scale (AIS) at admission of all persons with TSCI were recorded. The various terms and definitions used in the study were as per the ASIA International Standards for Neurological and Functional Classification of TSCI.⁹

In order to get further insight into fall from height (FFH) and road traffic accident (RTA) as a mode of injury, a telephone survey was done questioning directly 200 randomly selected persons with TSCI in the study in whom RTA and another 150 in whom FFH was the mode of injury. Especially designed questionnaires were used for the survey.

RESULTS

Figure 1 depicts the geographical location of persons with TSCI in the study. A total of 40.51% of the persons with TSCI were from the urban areas whereas 53.95% were from rural areas. The status of 5.54% could not be determined from the records.

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Figure 1 The state-wise geographical location of the persons in the study.

The injury admission to ISIC interval and the number of institutional transfers before reaching ISIC are depicted in Tables 1 and 2, respectively.

The most commonly affected age group was 20–29 years, accounting for 34.18% ($n=389$) of the persons with TSCI in the study (Figure 2). A total of 68.54% ($n=780$) of TSCI were under 40 years at the time of sustaining injury. The mean age at injury was 34.4 years. For males the mean age was 34.3 years and for females 35.0 years. The median age at injury was 32 years, and the most frequently occurring age at injury (mode) 30 years.

Overall, 85.5% of persons with TSCI in our study were males whereas only 14.5% were females (Figure 2), with a male:female ratio of 5.9:1. This disparity between males and females was more obvious in the 20–29 years age group, and gradually reduced with age.

At the time of injury 63.18% were married, 32.43% unmarried, 0.18% divorced, 0.09% widowed and none were separated whereas the marital status of 4.13% could not be determined from the records.

The educational level, vocational status, day of the week distribution and month of the year distribution are depicted in Tables 3–6, respectively.

A total of 34.08% of the spinal injured had other associated injuries (Table 7). Associated orthopedic injuries were the commonest (23.18%), followed by chest injuries (11.07%), head injuries (5.54%) and other spine fracture (2.94%).

Upper cervical (C0–C2), lower cervical (C3–7), thoracic (T1–10), thoraco-lumbar (T11–L1) and lumbar (below L1) regions accounted for 0.81, 36.51, 27.34, 30.49 and 4.86% of the vertebral injuries, respectively. D12 and C5 were the most common vertebral level of injury and each accounted for 15.83% of the persons with TSCI

Table 1 The injury admission to ISIC interval in persons with TSCI

Injury admission to ISIC interval	%
<1 Day	8.06
1–2 Days	18.36
3–7 Days	31.31
8–30 Days	16.78
1–3 Months	10.44
>3 Months	15.06

Abbreviations: ISIC, Indian Spinal Injuries Centre; TSCI, traumatic spinal cord injury.
Data available for 757 persons.

Table 2 The number of institutional transfers before reaching ISIC

No. of institutional transfers	%
0	13.94
1	59.50
2	20.45
3	3.72
>3	2.39

Abbreviation: ISIC, Indian Spinal Injuries Centre.
Data available for 753 persons.

(Figure 3). On the other hand, the neurological level was upper cervical in 0.36%, lower cervical in 32.79%, thoracic in 28.97%, thoraco-lumbar in 29.16% and lumbar in 8.72% (Figure 3).

The type and severity (completeness) of injury and AIS at admission are depicted in Figure 4 and Table 8, respectively.

Figure 2 The Age (at the time of injury) with gender comparison.

Table 3 The educational level in persons with TSCI

Education level	%
Uneducated	8.07
8th Grade or less	8.93
Up to 10th class	14.89
Up to 12th class	33.72
Bachelor degree	28.34
Master degree	5.57
Doctorate	0.48

Abbreviation: TSCI, traumatic spinal cord injury.
Data available for 1041 persons.

Table 4 The vocational status before injury in persons with TSCI

Employment status	%
Student	12.26
Labor	8.40
Nonprofessional job	18.02
Professional in private job	17.26
Self-employed professionals	3.77
Professional in government job	8.40
Business	10.85
Home maker	7.45
Unemployed	11.42
Other	2.17

Abbreviation: TSCI, traumatic spinal cord injury.
Data available for 1060 persons.

RTA (45%) and FFH (39.63%) were the most common mode of injury (Table 9). Assault, fall of load from overhead, sports and other causes accounted for 5.27, 2.4, 2.28 and 1.23% of injuries, respectively.

The survey of 200 persons with TSCI who had sustained injury as a result of RTA (Table 10) revealed that TSCI occurred in four-wheeled passenger vehicles like cars in 48.5% (which included sports utility vehicle in 6.5%), motorized two wheelers in 44%, non-motorized transport users including pedestrians and cyclists (non-motorized two wheelers) in 5% and three wheelers in 2.5%.

Table 5 The day of the week distribution at the time of injury in persons with TSCI

Day of the week	%
Monday	16.19
Tuesday	11.68
Wednesday	16.49
Thursday	13.35
Friday	13.25
Saturday	12.86
Sunday	16.19

Abbreviation: TSCI, traumatic spinal cord injury.
Data available for 1019 persons.

Table 6 The month of the year distribution of injury in persons with TSCI

Month of the year	%
January	6.67
February	7.33
March	8.38
April	9.24
May	9.62
June	10.67
July	9.33
August	8.38
September	6.38
October	9.14
November	7.90
December	6.95

Abbreviation: TSCI, traumatic spinal cord injury.
Data available for 1050 persons.

Table 7 Associated injuries in persons with TSCI

Associated injuries	%
Head injury	5.54
Orthopedic fracture	23.18
Chest injury (hemothorax, pneumothorax, flail chest, rib fractures and so on)	11.07
Abdominal injury	2.60
Amputation	0.35
Major burns	0.52
Brachial plexus injury	1.04
Other spine fracture	2.94
Faciomaxillary trauma (fracture mandible and so on)	1.21
Others	6.06
None of the above	65.92

Abbreviation: TSCI, traumatic spinal cord injury.
Note: The percentages do not sum to 100 because some persons have more than one associated injury.

Overall, passengers and drivers were fairly evenly affected (48.5% versus 48%, respectively). Passengers of four-wheeler vehicle were most often afflicted with SCI (32%) in the survey, closely followed by two wheeled drivers (31.5%). Personal errors like high speed (51.5%) and improper judgement (52.5%) were the most common predisposing factors for RTA. Most (43%) of the accidents occurred during

Figure 3 The vertebral and neurological level at the time of admission in persons with TSCI.

Figure 4 The type and completeness of injury at the time of admission in persons with TSCI.

daytime (06:30–16:00) and owing to collision with heavy motor vehicle (53.6%). A total of 39.5% of accidents took place on highways whereas 60.5% took place on other roads.

The survey of persons with TSCI who had sustained injury due to FFH (Table 11) revealed that falls most commonly occurred from roof (22%). High falls (85.33%) were more common as compared with low falls (14.67%). Falls while walking/standing or from a height up

Table 8 The AIS at the time of injury in persons with TSCI

A/S	%
A	71.12
B	14.68
C	8.18
D	6.02

Abbreviations: AIS, ASIA Impairment Scale; ASIA, American Spinal Injury Association; TSCI, traumatic spinal cord injury.
Data available for 1063 persons.

to 3 feet were classified as low falls in our study. Most of the falls occurred at home or its surroundings (66%). Thoracolumbar and cervical levels were most commonly affected by falls.

DISCUSSION

It is well recognized that the best source for epidemiological data is a registry.¹⁰ Despite its huge size and population, India has not had any registry or proper epidemiology study so far. Pilot/Demographic studies have been conducted but the information from these studies may not be representative of the country. However, such studies suggest that there may be significant epidemiological differences in India as compared with other developed countries. An insight into the epidemiological/demographic details is important as this would have a bearing on framing strategies for prevention programs.

To the best of our knowledge, our study has the largest number of persons with TSCI among other published studies from the country,^{4–8} third largest among those from the continent^{11,12} and fourth largest among all published studies.^{11–13}

There is no structured health care delivery system for spinal injuries in India. People sustaining spinal injury can go to any hospital of their choice for management. As such there are very few dedicated spinal injury centers in the country. Thus, even though ISIC is recognized as the tertiary level spinal injury center, it receives all types of spinal injury patients either directly, or through referral as the first definitive hospital for comprehensive management or after surgery for rehabilitation or for completing rehabilitation after initiation or for management of complex cases.

The geographic distribution of persons with TSCI in our study revealed a fairly large coverage area of northern, eastern, western and central India. There are very few dedicated spinal injury centers in India and thus persons with TSCI need to travel large distances.

The rural versus urban background ratio was approximately 1.3:1 as against the ratio of 3:1 for the Indian population.¹⁴ Rather than suggesting a lower incidence of TSCI in the rural population, it may suggest a larger coverage of urban-based persons with TSCI by our center. The other Indian pilot studies have not made mention in this regard but we presume that this is perhaps the only study where there was an equal distribution from Urban and Rural regions.

The demographics vary with geographical, rural–urban, and other socio-cultural population factors. The diverse population due to the large geographical size and diversity in other mentioned factors makes it difficult to have data truly representative of the whole population. In the absence of a registry, the study may be considered to be the most representative among available literature for the Indian population as it had more number of persons with TSCI, covered the largest geographical location and had an even distribution of TSCI from urban as well as rural background.

Table 9 The mode of injury in different studies from Indian literature

Author	Assessment year	Mode of injury (%)					
		Falls	RTA	Sports	Fall of load overhead	Assault	Others
Present study ^a	2002–2010	39.60	45.00	2.28	2.40	5.20	1.20
Agarwal <i>et al.</i> ⁴	2003–2004	58.90	21.30	–	7.20	–	12.60
Singh <i>et al.</i> ⁵	2000–2001	46.40	34.90	3.90	3.50	2.70	8.70
Dave <i>et al.</i> ⁸	1980–1989	49.40	36.50	–	8.20	1.80	4.10
Chacko <i>et al.</i> ⁷	1980–1986	55.20	12.80	–	18.40	–	13.60
Shanmugasundaram ⁶	1978–1986	66.00	34.00 ^b				

Abbreviation: RTA, road traffic accident.

^aData not available from 4.22%.^bTotal percentage for other causes as available.

The percentage of patients admitted within the first 48 h and week after injury was significantly higher (18.36 and 57.73%) than in the Italian study¹⁵ (13.7 and 18%). This may be due to the fact that ISIC receives patients even immediately after the injury whereas in the Italian study many institutions admitted patients for rehabilitation after they had been managed in another hospital. However, the percentage of patients admitted on the first day were significantly lower than that in another Indian study⁵. This other Indian hospital in a smaller city probably receives more patients directly as it is a public institution and there are hardly any other options for patients. Mean time from injury to admission was higher (47.18 days) than that in the study from Italy¹⁵ (36.8 days). This may be due to the larger range of injury admission interval in our study (<1 day to 8 years). A significant number of patients had been sent back home from the previous institution after surgical or conservative management of vertebral lesion and reported to us quite late for rehabilitation.

A total of 13.94% patients came directly to ISIC for admission as opposed to 3.5% in the Italian¹⁵ and 76.19% in the other Indian study.⁵ A significant number (26.56%) had been admitted to more than one other institution before admission to ISIC. This and the significantly high percentage of patients presenting late for comprehensive rehabilitation highlights the need for creating awareness among the community and professionals on the need for timely and comprehensive management of spinal injuries.

The mean age at injury of 34.4 years in our study is more or less similar to that in studies from Turkey,^{16,17} Fiji,¹⁸ Kentucky¹⁹ and other studies from India,^{4–8} less than that in the studies from the USA²⁰ (37.6 years) and Italy (38.5 years¹⁵ and 37.1 years²¹), and much less than the studies in Portugal²² (50 years), Japan¹¹ (48.5 years), Taiwan²³ (44–46 years), Germany²⁴ (43.8 years), Canada²⁵ (42.2 years), eastern Canada²⁶ (55.4 years) and western Canada²⁷ (35 years). A closer look reveals that studies in which mean age was lower (as in our study) are older studies. With passage of time mean age at injury is increasing especially in developed countries.²⁸

The proportion of persons who were at least 61 years of age at time of injury is 5%. This is lower than the proportion in the USA in 2009²⁹ (8.39%) and much lower than that in eastern Canada in 2003²⁶ (48%). Thus, the mean age and the percentage of geriatric population sustaining SCI is lower in our study than in developed countries. This may be compatible with a reduced life expectancy of the Indian population³⁰ as compared with that of most developed nations.³⁰ As the life expectancy and thus the percentage of geriatric population increases, this figure is likely to increase. This has important implications, as older persons who incur SCI have more

pre-existing major medical conditions, are more likely to have tetraplegia, develop secondary medical complications during acute care and rehabilitation and have more frequent rehospitalizations than their younger counterparts.^{31–33}

The male female ratio (5.9:1) is much higher in our study as compared with that in other studies from across the globe¹ (3.8:1) and some studies in the country.^{4–6} This lower predisposition of Indian females to TSCI may be due to the fact that most Indian women are housewives. India has one of the lowest percentages of female professional and technical workers (20.5%).³⁴ However, as witnessed in developed countries, the incidence in women is likely to increase with time.

A significantly higher percentage of TSCI, that is 63.18% were married at the time of injury in our study as compared with those in the studies from USA (30.6%).³⁵ This may reflect the lower mean age at which most Indians get married.³⁶ This and the lower divorce rate amongst Indians in general³⁷ may result in more family support, lesser psychosocial issues and easier adaptation at home. Most other studies have not commented on the marital status.

A total of 68.11% of persons with TSCI had completed at least 12th class at the time of injury as against 59.3% in the US NSCISC database. Overall, 82.7% of persons with TSCI in the study were educated to at least 10th standard. A very large percentage of persons with TSCI in our study were males and thus this may be representative of the literacy rate in our study (75% and 82%, respectively in males in 2001 and 2011 as against the overall rate of 65% and 74% in these corresponding years).³⁸

In all, 66.7% persons with TSCI in our study were employed at the time of injury as against 85.5% in NSCISC database. The higher percentage of employed persons with TSCI in our study than that in the India population³⁸ (48.24%) may be due to the fact that only those with a better occupational (and thus economic) status could travel large distances to seek treatment at our center.

The study did not reveal any set pattern with regard to day of week distribution of injury. There was no predisposition of injuries towards weekends as has been found in some studies.³⁵ In fact, Saturday was one of the least common days for injury. One of the reasons for this difference could be the fact that a very small percentage of Indians engage in travel, adventure or sports activities during the weekend as compared with people in developed countries.

Even though the injuries were quite evenly distributed over the year, June and May were the most common months for injury in the study in keeping with the findings of other studies,^{5,35} where most of the injuries took place during the summer months because of

Table 10 The findings of the telephonic survey undertaken for 200 persons who sustained TSCI as a result of RTA

<i>(a) Gender distribution</i>	
<i>Gender</i>	<i>%</i>
Female	14.00
Male	86.00
<i>(b) Age distribution</i>	
<i>Age group</i>	<i>%</i>
≤ 18	5.50
19–29	46.00
30–39	24.00
40–49	14.00
50–59	8.00
60–69	1.50
> 70	1.00
<i>(c) Driver/passenger status</i>	
<i>Driver/passenger status of persons with TSCI</i>	<i>%</i>
Motor cycle driver	24.50
Motor cycle pillion	10.50
Scooter driver	7.00
Scooter pillion	2.00
Three wheeler driver	0.00
Three wheeler passenger	2.50
Four wheeler driver	16.50
Four wheeler passenger	32.00
Non-motorized pillion	1.50
Not applicable	3.50
<i>(d) Distribution of vertebral segment injured</i>	
<i>Level</i>	<i>%</i>
Cervical	41.00
Cervico thoracic	0.50
Thoracic	30.50
Thoraco-lumbar	17.00
Lumbar	11.00
<i>(e) Duration of the day when RTA occurred</i>	
<i>Day duration</i>	<i>%</i>
Daytime	43.00
Dawn	25.00
Night or early morning	32.00
<i>(f) The location of RTA with regard to highways and other roads</i>	
<i>Location of RTA</i>	<i>%</i>
Highway	39.50
Other roads	60.50
<i>(g) Type of vehicle occupied or pedestrian status at the time of RTA</i>	
<i>Type of vehicle occupied/pedestrian status</i>	<i>%</i>
Pedestrian	3.00
Cyclist	0.50
Scooter	9.00
Motor cycle	35.00
Three wheeler	3.00
Four wheeler* (*car: 33.5%, bus: 5.5%, truck: 2.5%)	41.50

Table 10 (Continued)

<i>(g) Type of vehicle occupied or pedestrian status at the time of RTA</i>	
Four wheeler SUV	6.50
Non-motorized vehicle	1.50
<i>(h) Predisposing factors for RTA</i>	
<i>Predisposing factors</i>	<i>%</i>
Poor road infrastructure	23.00
Mechanical failure	6.50
High speed	51.50
Improper judgement	52.50
Self	11.00
Environmental factor	4.00
Influence of alcohol	4.50
Old poorly maintained vehicle	0.50
Overloaded vehicle	0.50
Unfavorable driving	12.00
Poor traffic management	1.50
No factor	7.50
<i>(i) Type of collider</i>	
<i>Collider</i>	<i>%</i>
HMV	53.60
LMV	21.60
Living being	9.60
Object	8.00
Other	7.20

Abbreviations: HMV, heavy motor vehicle; LMV, light motor vehicle; RTA, road traffic accident; SUV, sports utility vehicle; TSCI, traumatic spinal cord injury.

increased traveling and activities (including adventure activities) during summer time.

RTAs was the most common and FFH the second most common mode of injury in our study, respectively. This observation is similar to that of most other studies from developed countries but in contrast to other Indian^{4,5,7,8} (Table 9) and southern Asian/Oceanian³⁹ studies in which FFH has been the commonest mode of injury. The different observation in other Indian pilot studies may be more due to regional variation. Fall from trees was the most common cause of falls in the study by Chacko *et al.*⁷ This is prevalent in some parts of India and Southern Asia/Oceania region.³⁹ However, as mentioned earlier, our study may be more representative of the Indian scenario. The mode of injury also did not show any substantial difference among the urban and the rural subsets of the persons with TSCI in our study.

RTA is the most common cause of injury in India^{3,40} and hence is expected to be the most common cause of TSCI as well. As per the first global status report on road safety of the World Health Organization (WHO), India has the dubious distinction of leading the world in the number of deaths due to RTA.⁴¹ As per the National Crime Records Bureau, 14–15 people die every hour in road accidents in the country.⁴² However, the fatalities per 1 00 000 population is lower in India ($n = 6$) than in some other countries like Malaysia⁴³ ($n = 31$), suggesting that the large number of deaths may be due to the large population. Similarly, fatalities per 10 000 licensed motor vehicles may be higher in India ($n = 20$) than in developed countries (1.1–5.0) but lower than in other countries like Ethiopia⁴³ ($n = 195$).

Various factors may be responsible for the high incidence of RTA in India. Different mindset and low driving standards are important

Table 11 Shows the findings of the telephone survey undertaken for 150 persons sustaining TSCI as a result of fall

(a) Gender distribution

Gender	%
Male	82.67
Female	17.33

(b) Age distribution

Age (years)	%
≤18	10.00
19–29	33.33
30–39	26.67
40–49	14.00
50–59	10.00
60–69	2.67
>70	3.33

(c) Place of fall

Place of fall	%
Home or its surroundings	66.00
Outdoor during leisure	16.67
Work place	17.33

(d) Distribution of vertebral level

Vertebral level	High falls (%)	Low falls (%)	Total (%)
Cervical	12.67	6.67	19.34
Cervico-thoracic	13.33	1.33	14.66
Thoracic	22.00	2.66	24.66
Thoraco-lumbar	32.67	2.67	35.34
Lumbar	4.67	1.33	6.00
Total	85.34	14.66	100.00

(e) Height of the fall

Height	%
High fall	85.33
Low fall	
On floor	11.33
Low height	3.34

(f) Fall location

Fall location	%
Floor	11.33
Construction site	2.00
Tree	12.00
Balcony	16.67
Electric Pole	15.33
Jangla (iron mesh)	0.67
Stairs	14.67
Roof	22.00
Well	3.33
Unprotected sewer	0.67
Others	1.33

(g) Predisposing factors for fall

Predisposing factors	%
Alcohol	0.67
Electric shock	16.00
Infrastructural factor	19.33
Others	6.00
None	58.00

factors.^{3,44} Traffic rules are often viewed as an imposition and there is a tendency to flout them. Thus, high speeds and other human errors leading to RTA is quiet common. Human error was attributed as a sole cause in 52.5% of the accidents in our study. Other studies report human error as sole cause in 57% of all accidents³ and a contributing factor in over 90% of all accidents. This stresses the huge importance of prevention programs including public awareness and education.

A total of 35% of persons with TSCI in our survey ascribed poor road infrastructure and unfavorable driving conditions as a predisposing factor for the RTA. Inappropriate design and maintenance of not only the roads but also highways as well as defective street lighting leading to poor visibility of vehicles and roads have been generally implicated.⁴⁵ Highways often pass through semi urban areas. Even though Indian highways comprise only 2% of the total road network, they account for >25% of fatal injuries, indicating specific causative factors in national highways.³ Of all RTA's leading to TSCI in our survey, 39.5% occurred on highways as against 60.5% on other roads.

The low percentage of improper traffic management as a predisposing factor probably reflects a low awareness among persons with TSCI of good traffic management techniques. Experts implicate improper segregation of traffic and pedestrians, overloaded vehicles, significant volume of non-motorized traffic not only on the urban as well as rural roads but also on four-laned divided highways and deteriorating traffic law enforcement due to the absence of enforcing teams, skills, facilities and resources as significant predisposing factors.³ Other implicated factors include limited scientific crash investigation, analysis and dissemination of information.⁴⁵

Mechanical failure was the sole cause in 6.5% of accidents in our survey and 3% of accidents in other Indian studies.⁴⁴ Old poorly maintained vehicles add to the problem. Environmental factors contributed to 4% of RTA's in our survey and 0.9% in other studies.⁴⁴

The survey revealed that there were more accidents involving four wheeled vehicles like cars (48%) and two wheelers were a close second (44%). In South East Asia, two-wheeled (and non standard) road transport accidents predominate as the major cause of TSCI.³⁹ In contrast, the majority (80%) of the RTA's in the NSCISC database³³ were automobile crashes, whereas motorcycles accounted for 13 percent. Other studies also revealed that major cause of TSCI in North American, Western Europe and Australian regions involves four-wheeled motor vehicle accidents.³⁹ There are a much higher proportion of two wheelers in India than in high-income countries. Cars comprise only around 10% of the total vehicles whereas 75% are motorized two wheelers. In high-income countries, however, 70–80% of vehicles are cars and only 5–10% are motorized two wheelers.³ Thus, motorized two wheelers are more likely to be involved in accidents in India. As per the Ministry of Road Transport and Highways' Transport Research Wing's report of 2001–2002³ also, thirty–forty percent of total deaths and injuries occur among motorized two-wheeler riders and pillion riders. Another study has suggested that pedestrians, two-wheeler occupants and bicyclists are killed and injured in greater numbers in India in RTA.³

Heavy motor vehicles were the collidor in a large majority of cases (53.6%). Drivers constituted a higher percentage of persons sustaining TSCI in our study (53%) but pillion riders/passengers were also a significant percentage (43%) reinforcing the need for safety regulations for both. The RTA took place more often (57%) during dark hours or dim light, that is, night or early morning or dawn. However, a significant number of injuries also took place during daytime (43%). In the USA,³³ RTA mainly took place during daytime whereas in another Indian study³ RTA's were more common during night (28%) and early morning hours (18%).

FFH was the second most common cause of TSCI in our study. Some causes of falls in our study, which may be unique to India and may not have been reported as yet, include fall from electricity pole, fall from a vehicle due to the *Duputta* (large scarf-like apparel worn around the neck in a typical Indian dress) getting entangled in the wheels of a two or three wheeler vehicle, fall from an overloaded vehicle like a tractor, fall down one floor due to a *Jangla* (iron mesh on the floor in old houses which can be opened in order to lift large objects from a lower floor since the narrow winding stair case in such houses do not allow large objects to be taken up) left open and fall from terrace while running after or flying kites. Other causes rare in other parts of the developed world include fall from trees, fall into unprotected well or sewer, fall from a camel, fall while house painting and fall while repairing appliances like air-cooler at a height.

A survey of 150 of persons with TSCI in our study who had sustained spinal injury due to fall revealed that falls were more often at home or its surroundings than at work. Even though infrastructural factors and electric shock predisposed to falls in 19.33% and 16% respectively, in most of the falls (58%) there was no predisposing factor. Falls were most often from terrace or balcony. Fall from terrace is a common cause in rural and semi urban regions where parapets of terraces are often missing. A common scenario is that of a person visiting a relative in a village. They sleep on the terrace after a binge of alcohol. During the night, the individual gets up for a nature's call. Half asleep, still under the influence of alcohol and in a new surrounding, he just walks over the unprotected terrace and sustains a spinal injury.

Falls from balcony took place while repairing an air-cooler or other appliance fitted in the balcony, bending over to catch something thrown from below or stepping over a balcony with un-constructed parapet or railing while inspecting the construction work. Three peculiar causes of fall from balcony included sustaining a seizure while standing at the edge of balcony, jumping off the balcony on being attacked by a monkey and while trying to escape from a fire.

Fall from electric poles was a close second and took place while at work or while trying to steal electricity. This mode of injury has not been reported in literature so far. Interestingly, no extremity fractures were found in this group of persons with TSCI. Electric shocks lead to a loss of balance and the person falls backwards with the dorsal aspect making impact with the ground. Extremity fractures do not take place most probably as there is no protective righting reflex. The associated electric burns also need to be managed.

Fall from stairs was the third most common cause of spinal injury due to fall in our study. Old Indian houses generally have steep, narrow stairs with high steps and predispose to falls.

Fall from trees was the fourth most common cause of falls. This is common in rural areas and in Southern India where falls from trees generally happen during toddy tapping and coconut plucking. Falls also occur while climbing trees for leisure, to pluck fruits, to collect wood or to collect stuck items like kites etc. In some Indian studies, fall from tree has been reported as the most common cause of falls and spinal injuries.⁷

Low falls accounted for approximately 20% of all falls in the survey. Low falls has been reported to be a common cause of injury in the elderly.^{39,46} In our study, most (50%) of the low falls were in the age group > 50 years. The incidence of fall due to low falls is likely to increase as the geriatric population of the country is increasing.

FFH are more likely to injure the lumbar spine.⁴ In our study too, persons suffering spinal injury as a result of high fall had a 34.2% and 24.9% higher involvement of lumbar and thoraco-lumbar spine, respectively, as compared with the overall study. Low falls are more

likely to result in cervical spine injuries (33.33%), which are more often odontoid fractures, central cord injuries and cervical extension/distraction injuries ('open-book' fracture).⁴⁶ In our survey, too low falls affected the cervical spine in 54.5%.

Shanmugasundaram⁶ reported that there is likely to be a higher percentage of neurological improvement in spinal injuries due to falls as the injury may be of lesser severity than from high-velocity injuries. However, in our study the percentage of incomplete injuries in falls (28.8%) has been the same as in the overall study (28.03%). This difference may be due to the fact that most of the falls in the other study have been from a lower height and/or to a softer surface like from trees, whereas the falls in our study were more often from higher heights like terraces or balconies and on a harder surface.

Fall of load from height while manually unloading vehicles or due to collapse of old or under-construction building, wall or mine are causes more often seen in emerging nations and accounted for 2.37% of injuries in our study. Collapse of buildings during natural calamities like earthquake or tsunami also causes TSCI but our study did not report any such injury.

Fall while carrying heavy load on head is another cause more often seen in emerging nations but accounted for only three injuries in our study.

In many developed countries, sports and recreational activities have become much more frequent causes of SCI (12.8%)³⁵ as leisure time has increased and the variety of risk-taking recreational activities have proliferated. However, sports injuries accounted for only 2.28% ($n = 26$) of TSCI in our study reflecting the lower popularity of sports as a hobby in India. Some sports like kabaddi and Indian wrestling are played mainly in India and accounted for 5 injuries in our study. These sports have a potential for injury and rules and regulations aimed at prevention are not stringent. Diving into shallow water accounted for 1.85% ($n = 21$) of injuries. The figure rises in summer months as young males dive into shallow water bodies to get respite from heat. Thus, 15 of 21 diving injuries in our study occurred during the month of May, June and July.

Violence has shown a substantial increase in the past 10 years and accounted for 10–38% of injuries^{35,39,47} with Sub Saharan Africa reporting the highest rates (38%). It (especially gunshot injuries) is the most common cause of TSCI in some urban locations. In our study, it accounted for 5.71% of injuries.

In most studies from developed countries, cervical injuries constituted the most common vertebral level (52.5–66%) followed by thoracic (24.9%), thoraco-lumbar (15.6%) and lumbar (6.2%).^{17,35,48,49} However, spinal injuries in our study were more evenly distributed among cervical (36.47%), thoraco-lumbar (29.79%) and thoracic (26.71%) vertebral segments.

C5 (13.44%), L1 (12.81%) and T12 (12.17%) were the commonest neurological level in our study against C5 (15.7%), C4 (12.7%), C6 (12.6%), T12 (7.6%), C7 (6.3%) and L1 (4.8%) from NSCISC database.³⁵ In all, 32.43% of persons with TSCI in our study were tetraplegics and 64.85% were paraplegics. This is in contrast to studies from developed countries where tetraplegics account for 41.3–57.32% of persons with TSCI.^{1,34} Preferential thoraco-lumbar and lumbar injuries in falls, lower mean age of TSCI in our study (after the age of 46 the percentage of persons with tetraplegia increases rapidly with advancing age),³⁵ lower survival rates of cervical injuries and relative inability of fresh cervical injuries to travel large distances may be some of the reasons for the higher proportion of thoraco-lumbar and thoracic injuries in our study.

There were a significantly higher percentage of complete injuries in our study (69.3%) as compared with most other studies

(33.9–58%).^{17,24,50–52} The almost non-existent pre-hospital care, improper/inadequate emergency medical services in the facility providing initial treatment, the delay in reaching facility providing definitive treatment and a lower incidence of cervical spine injuries (which are more likely to be incomplete) may be some of the factors responsible for this. The experience in developed countries has shown that proper implementation of these services had a substantial impact on reducing the percentage of complete injuries.⁵⁰

Our study provides information which gives insight into demographics of SCI from our country. It would be worthwhile to have information from the whole region as well. It would also be useful to study the pre-hospital care and survival rate. Similarly, information about long-term outcomes at follow-up including social and vocational outcomes is desirable. We hope to look into these aspects in subsequent studies.

CONCLUSIONS

This study had the largest number of persons with TSCI as compared with other published studies from the country. The data should be the most representative among those available for the Indian population. It suggests that the demographics of spinal injuries in India differ significantly from that in other developed countries. There is a lower mean age and percentage of geriatric population. There is a much larger number of males, paraplegics, complete injuries, those married at the time of injury and those suffering injuries due to RTA's involving two wheelers and falls (from terraces, balconies, electric poles, stairs and trees). There was no set pattern with regards to the day-wise distribution of injuries. In contrast to other published studies from the country, RTA was the most common mode of injury in our study. Human error, poor road infrastructure and unfavorable driving conditions most often predisposed to RTA. The significantly higher number of complete injuries and lower percentage of cervical injuries probably reflects the need to establish proper services for pre-hospital and acute care. There is a need for a proper epidemiological study, which could confirm the findings of the study and help develop prevention programs accordingly.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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