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Summary

This report presents national statistics on spinal cord injury (SCI) using data from case registrations to the Australian Spinal Cord Injury Registry (ASCIR) for 2007–08. Overall, the rates and causes of SCI, and characteristics of people affected by SCI, remained broadly similar to previous years.

A total of 362 new cases of SCI were reported in 2007–08—285 cases were due to trauma while 77 were due to other causes. The age-adjusted rate of persisting SCI from traumatic causes was similar to previous years at an estimated 15.0 new cases per million population (aged 15 years and older).

Incidence rates of SCI were higher for males than females at all ages. The average age at injury was 45 years, although patients who acquired an SCI traumatically were substantially younger on average than those who acquired their SCI non-traumatically (42 years vs 56 years).

Spinal cord injuries were most frequent in the 15–24 year age group. Increases in SCI numbers were seen in the 15–24 and the 65–74 year age group compared with the previous year. However, in the 25–34 year age category there was a decrease.

Patients with SCI tend to have lengthy hospitalisations. Overall, SCI patients had a median length of stay in hospital of 133 days.

Transport-related injuries (46%) and falls (28%) accounted for nearly three-quarters of the 285 cases of traumatic SCI during 2007–08. A substantial number of the transport-related cases (78%) were traffic crashes, with the remainder occurring in non-traffic situations such as off-road bike trails, beaches and farms.

Fifty-one per cent of transport incidents were motor vehicle occupants and 49% were unprotected road users, predominantly motorcyclists (79%). The vast majority of unprotected road users were male (92%), and they tended to be younger with over half (56%) in the 15–34 years age group. Motorcyclists formed the youngest group with an average age of 32 years.

Falls led to 81 cases of persisting SCI in 2007–08, slightly higher than the 78 cases in 2006–07. Sixty-four per cent (52 cases) of the injurious falls were from a height of 1 metre or more. This was notably higher than the 38 cases in 2006–07.

Falls on the same level or from less than 1 metre led to spinal cord injury in 29 cases, which were 11 cases fewer than in 2006–07. Forty-one per cent of low falls involved people aged 65 years or over, compared to only 13% of falls greater than 1 metre involving this age group.

The activity being undertaken at the time of SCI was documented in half of all SCI cases. Leisure activities accounted for 35% of these, with just over half being attributed to diving, surfing, swimming or jumping into bodies of water. SCIs occurred across a range of sporting activities, including motorised sports (trail bike and motocross racing) (45% of sporting activity causes), the major football codes (25%), pedal cycle races (9%) and horse-related activities (9%).

Working for income was documented in 39 cases of SCI, with 44% related to transport incidents, 23% as a result of falls over 1 metre and 23% reported as being struck or colliding with a person or object.

1 Introduction

Spinal cord injury (SCI) can occur at any age and the effects can be permanent and devastating. Advances in critical care and rehabilitation medicine since the 1950s have resulted in reductions in mortality and increased life expectancy for those with SCI (Krause et al. 2004). These secular trends have been documented in Australia (O'Connor 2005; Soden et al. 2000), Europe (Dahlberg et al. 2005), Israel (Catz et al. 2002) and North America (Dryden et al. 2003; Pickett et al. 2003; Saunders et al. 2009; Strauss et al. 2006).

Internationally, incidence rates for SCI range from 10 to 40 cases per million population (Wyndaele & Wyndaele 2006). In Australia, about 300–400* new cases of SCI from traumatic and non-traumatic causes occur each year. The decreased mortality and improvements in life expectancy have resulted in an increasing prevalence of patients living with SCI. O'Connor (2005) estimates the age-standardised SCI incidence rate for Australia at 14.5 per million persons and predicts an increase in the prevalent population to between 10,500 and 12,000 by 2021. Based on 2005 cost estimates (Walsh et al. 2005), the ongoing costs associated with the long-term care of the prevalent population are estimated to be nearly A$500 million per year.

The US Centers for Disease Control (CDC) case definition of SCI was adopted in Australia for registration of cases of SCI:

> … a case of spinal cord injury is defined as the occurrence of an acute, traumatic lesion of neural elements in the spinal canal (spinal cord and cauda equina) resulting in temporary or permanent sensory deficit, motor deficit, or bladder/bowel dysfunction (Thurman et al. 1995).

This report presents:

1. statistical information on new cases of SCI in Australia to Australian residents who were injured and admitted to any of the six spinal units and reported to the National Injury Surveillance Unit (NISU) during the period 1 July 2007 to 30 June 2008 (this period is abbreviated as '2007–08' in this report)
2. clinical information on patients injured and admitted during 2007–08 who were Australian residents and acquired a persisting neurological deficit from injury to their spinal cord during 2007–08, and
3. information on external causes of SCI to Australian residents and overseas visitors who were injured and admitted during 2007–08.

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* This number underestimates the total number of incident cases of SCI as it only represents those people admitted to spinal units. Cases not admitted to these units include cases in which death occurs soon after injury, and cases in which the presence of other conditions necessitate treatment elsewhere (see Appendix for further information on ascertainment).

Section 2 of the report presents an overview of case registration and reporting by spinal units, with a particular focus on the characteristics of the patients admitted during 2007–08. Section 3 reports on the incidence of persisting SCI from traumatic causes in Australian residents, including trends, the incidence of SCI by state and territory of usual residence, and a description of socio-demographic characteristics. Section 4 provides a clinical description of SCI cases of Australian residents injured and treated in 2007–08 who had a persisting neurological deficit 90 days after injury or at discharge from rehabilitation. Section 5, the last section, provides information on external causes of injury and factors associated with the SCI event for all traumatic cases (Australian residents and overseas visitors).

Early reports, based on data from the period 1995–96 to 1998–99, were published in the *Australian injury prevention bulletin*, and more recent publications, based on ASCIR data from the period 1999–2000 to 2006–07, have been reported in the AIHW's *Injury research and statistics series*. The previous report in this series was based on ASCIR data from the 2006–07 period (Cripps 2009). Terms used in the report are defined in the Glossary (p. 29).

In 2007–08, the ASCIR was in its 13th year of operation. To date almost 11,900 cases of persisting SCI have been registered.

2 Overview of SCI case registrations in 2007–08

This report has been generated from data collected by Australia's six spinal units (SUs) specialising in acute management and rehabilitation of SCI patients during 2007–08. The SUs are tertiary referral centres for patients requiring specialist management of SCI. Patients from states and territories which have no SUs (Tasmania, the Northern Territory and the Australian Capital Territory) are generally sent to the nearest available SU in another state for treatment. Treatment of newly incident SCI cases comprises only part of the workload of SUs. These SUs also provide outpatient and outreach care as well as inpatient care for those readmitted for various reasons, sometimes long after the date of injury. Complete enumeration of new incident cases was confirmed by the Director or nominated staff at each SU and a quality assurance audit of ASCIR data was completed before data analysis. The SUs reported 362 incident cases of SCI during 2007–08.

Data used in this report is based on a *cross-section* of data extracted from the ASCIR in February 2009 and includes discharged and non-discharged cases. Operation and management of ASCIR and data issues are summarised in Appendix 1.

The focus of this report is persisting SCI resulting from trauma. In the year 2007–08, 285 of the 362 new SCI cases (79%) reported by the SUs incurred their SCI from traumatic causes (Table 2.1). Twenty-one per cent of the cases of SCI registered in 2007–08 were from non-traumatic causes. In these cases, SCI was secondary to spinal canal stenosis (23%), vascular disorders (22%) such as spinal cord ischaemia or epidural haematoma, and infectious conditions (17%). Other conditions associated with non-traumatic SCI were disc herniation (17%), cancer (13%) and myelitis (8%). The average age of these non-traumatic cases was 56 years (S.D. = 17), compared with 42 years (S.D. = 20) for traumatic cases. There was a lower proportion of males in the non-traumatic injury group (57%) when compared to the traumatic injury group (84%). Patients with non-traumatic SCI had shorter durations of initial care (median 72 days; interquartile range 31–126 days) in contrast to the traumatic SCI cases (median 138 days; interquartile range 88–212 days).

Other cases included those where patients were admitted with suspected SCI or transient cord concussion but who had no lasting neurological deficit (n = 6), patients who were reported to have died while still hospitalised (n = 8) six of which were trauma related and two due to non-traumatic sequelae, and others who were non-residents of Australia who had their SCI in Australia (n = 7). This non-resident group is omitted from Australian incidence rate calculations, since the denominator is the population of usual residents of Australia. Australian residents who acquire a SCI while elsewhere are included in this report only if they are admitted to a spinal unit in Australia. In 2007–08 nine Australian residents were transferred to Australian SUs after incurring a SCI overseas.

Section 3 of the report deals with incident cases of persisting SCI from trauma in the Australian population (n = 266). Section 4 deals with the clinical characteristics of these newly incident cases of persisting SCI from trauma. Section 5 deals with the external causes of all traumatic cases of SCI during 2007–08 which were notified to the ASCIR (n = 285).

Table 2.1: Case registrations reported to ASCIR by spinal units; Australia 2007–08

Newly incident SCI case characteristics	Counts	Per cent
Traumatic causes:		
Australian residents		
Survived 90 days or to discharge, neurological deficit*	266	73
Survived 90 days or to discharge, no neurological deficit	6	2
Died on ward**	6	2
Non residents		
Survived to discharge, neurological deficit	7	2
Total traumatic causes* **	**285**	**79**
Non-traumatic causes:		
Australian residents		
Survived 90 days or to discharge, neurological deficit	75	21
Survived 90 days or to discharge, no neurological deficit	0	0
Died on ward**	*	*
Non resident		
Survived to discharge, neurological deficit	0	0
Total non-traumatic causes	**77**	**21**
Total newly incident SCI cases	**362**	**100**

* These cases are the focus of Sections 3 and 4 and include 23 patients who met the definition of persisting SCI and were inpatients at the time the report was written.

** The average age of the patients who died was 52 years.

*** These cases are the focus of Section 5.

3 Incidence of persisting SCI in 2007–08

This section of the report describes the incidence of persisting SCI from traumatic causes in Australian residents during 2007–08, and trends in rates for the period commencing 1995–96. The incidence of persisting SCI, as in previous reports, is based on a cross-section of ASCIR data for the 2007–08 financial year.

As in previous reports, paediatric cases (patients under the age of 15 years) were excluded from the incidence rate calculations because of the poor coverage of this group in the Register. Children with SCI are usually treated in paediatric intensive care units in specialist paediatric hospitals rather than SUs.

The ASCIR is continuously updated as information on patients arrives at NISU. Often this information comes after the closure of a reporting period (closure occurs following an audit/review period extending for one year after the reporting period ends) and is added to a case file. As a result, analysis of data from the register over longer periods of time (designated as *cumulative* data for the purposes of this report) will reflect these changes and additions and will not necessarily match the results of analyses on individual reporting periods (designated as cross-sectional data for the purposes of this report).

The section also includes the incidence of SCI by state and territory of usual residence and socio-demographic characteristics of these persisting SCI cases.

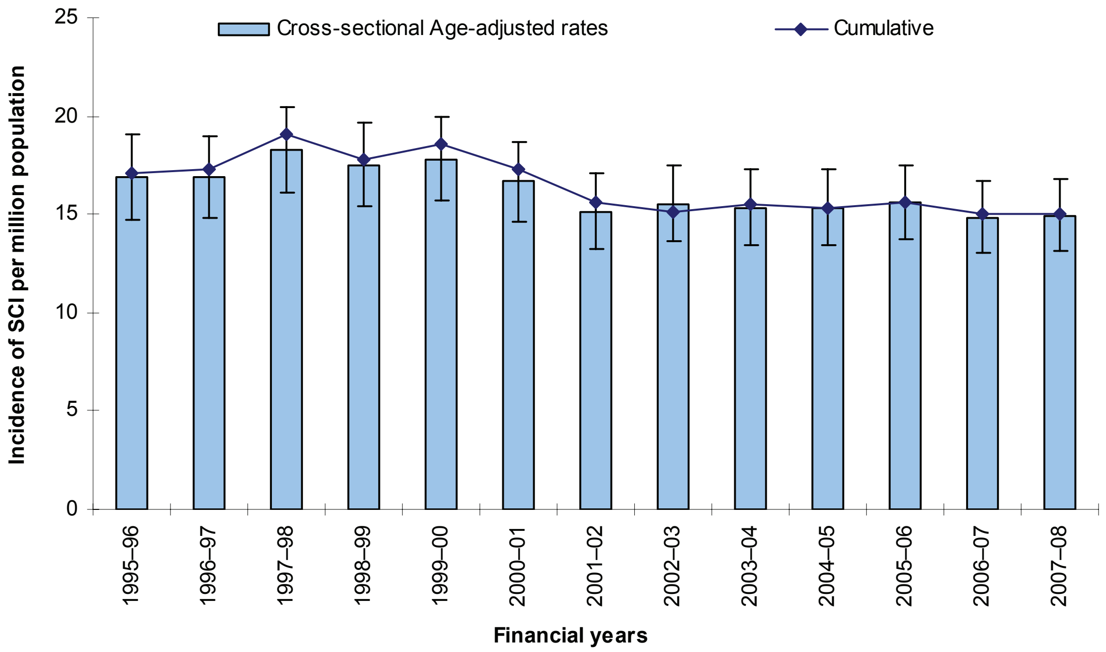
As is convention for this report, *persisting* cases of SCI have been defined as Australian residents who sustained their incident SCI in 2007–08 from traumatic causes, in Australia or overseas, and had an ASIA Impairment Scale score of A to D either 90 days post injury or at discharge from rehabilitation. At the time of writing this report, 23 of the 266 cases reported by SU had not been discharged from rehabilitation and remained inpatients. All had persisting neurological deficits and are included in this section.

3.1 Persisting SCI in 2007–08 and earlier years

The age-adjusted incidence rates of persisting SCI from traumatic causes in 2007–08 in the Australian population aged 15 years and older using cross-sectional and cumulative data are presented in Figure 3.1. The values shown are rates for persons aged 15 years and older standardised by the direct method to the Australian population in 2001.

The age-adjusted incidence rate of persisting SCI from traumatic causes in 2007–08 was estimated to be 15.0 new cases per million population (Figure 3.1). The rate was slightly higher than the rate in 2006–07 (14.9 new cases per million population), but not significantly different (95% CI=13.1–16.8).

As illustrated in Figure 3.1, point estimates of cross-sectional based rates when compared with rates based on cumulative data were lower, during the reporting periods 1997–98 through 2001–02 and higher in 2002–03. These differences reflect adjustments in case numbers due to routine auditing and periodic review of case registration data. From 2003 onwards the point estimates closely approximate the cumulative data.



Note: Error bars indicate 95% confidence intervals for cross-sectional rates.
Rates are based on cross-sectional data of persisting cases of SCI for Australian residents (266 cases in 2007–08).
Rates for reporting periods 1995–96 to 2006–07 are based on cumulative data.
Direct age standardisation was employed using the Australian population in 2001.

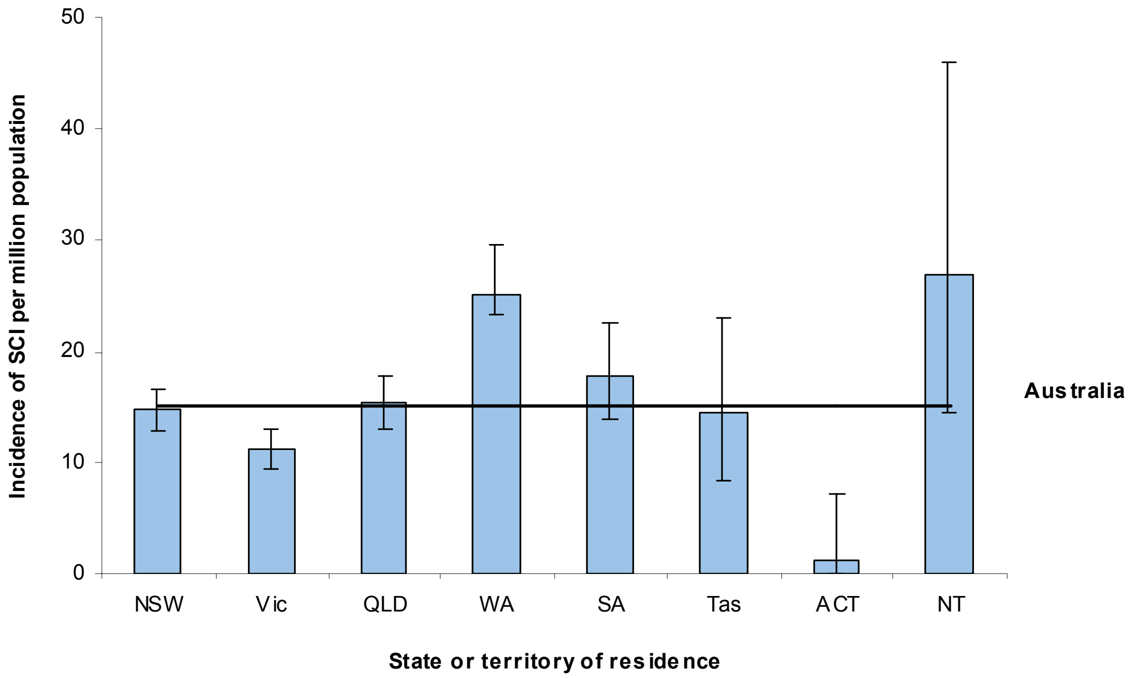
Figure 3.1: Incidence of persisting SCI from traumatic causes by year; Australia (age 15 years and over)

3.2 State or territory of usual residence

The age-adjusted rate of incidence of persisting SCI from traumatic causes by state and territory of usual residence is presented in Figure 3.2. Because of the small number of cases in some jurisdictions, incidence rates for jurisdictions are annual average rates based on cases in the three years 2004–05 to 2007–08 (this differs from calculations in reports before 2003–04).

Three-year case counts for Tasmania, the Northern Territory and the Australian Capital Territory were small, which is reflected in the wide confidence intervals for these jurisdictions.

Residents of the Northern Territory had a three-year annual average incidence rate of persisting SCI that was significantly higher than the national incidence rate (26.9 cases per million population versus 15.1 cases per million population over the three years). The rate for Western Australia was also significantly higher than the national incidence rate (25.1 cases per million population). Residents of Victoria and the Australian Capital Territory had three-year annual average incidence rates of persisting SCI significantly lower than the national incident rate (11.2 and 1.2 cases per million population, respectively). Overall, three-year incidence rates for each state were similar to the past two reports.



Note: Error bars indicate 95% confidence intervals for rates, based on Poisson distribution. Direct age standardisation was employed, taking the Australian population in 2001 as the standard. Three-year annual average rates, age 15 years and over is shown as the solid horizontal line.

Figure 3.2: Incidence of persisting SCI from traumatic causes by state or territory of usual residence; Australia 2005–06 to 2007–08

3.3 Remoteness of residence

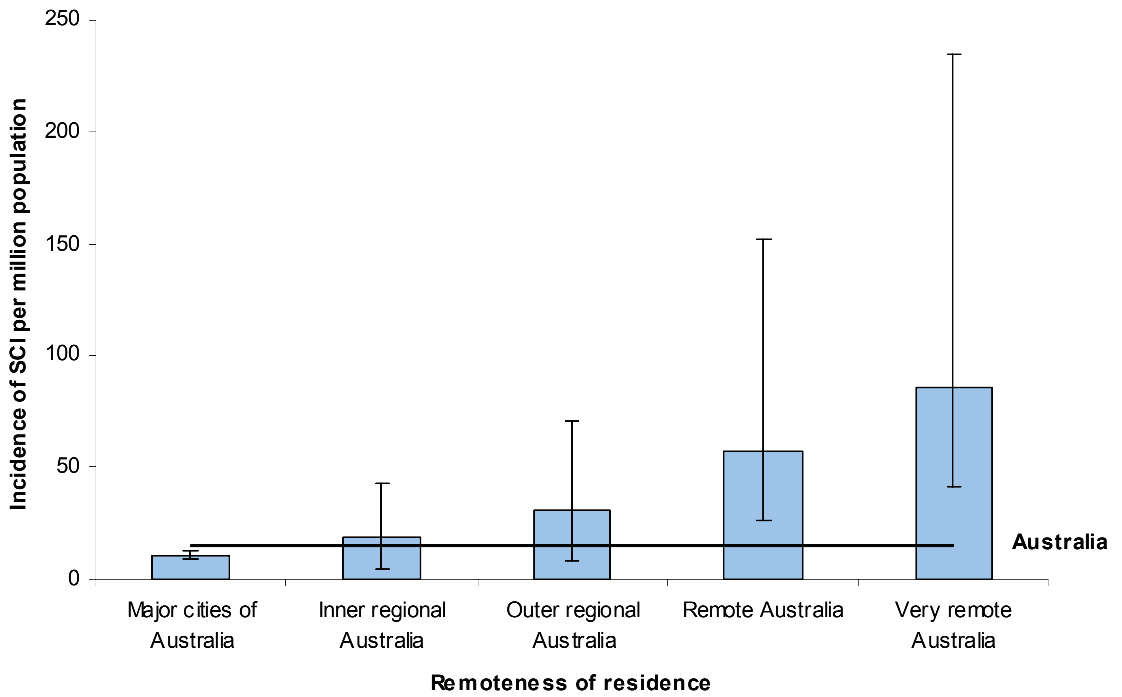
Remoteness of residence was obtained by converting postcodes present in the ASCIR to Australian Standard Geographical Classification zones (see Data issues). The age-adjusted rate of incidence of persisting SCI from traumatic causes by remoteness zone of a person's usual residence is presented in Figure 3.3. Annual incidence rates for *Inner-* and *Outer-regional Australia* were not significantly different from the national rate of 15.0 persisting SCI per million population. However, *Major cities* were significantly lower while *Remote* and *Very remote* were significantly higher than the national incidence rate. The rates for remoteness zones outside of *Major cities* increased with remoteness, with *Very remote* rates almost 8 times the *Major cities* rate of 11.0 persisting SCI per million population although this result and the result for *Remote* (over 5 times) must be interpreted with caution due to low case numbers. In comparison to the 2006–07 report the rate for *Major cities* and *Outer regional* has remained constant while the rate for *Inner regional* has fallen. In contrast, the incidence rates in *Remote* and *Very remote* regions have increased from 44.2 to 57.0 per million and 56.0 to 85.6 per million, respectively. Again the number of cases is small in these regions so care should be used when interpreting the numbers.

Of cases where both place of residence and place of injury occurrence could be determined (n = 188), nearly three-quarters (76%) occurred in the same remoteness zone as the place of usual residence. Thirty-two cases (17%) occurred in regions that were more remote than the usual residence; a hypothetical example of this may be a patient normally residing in Adelaide who incurs their injury in remote Coober Pedy. While 14 cases (7%) occurred in regions that were less remote than the usual residence. Another hypothetical example of this situation may be a resident of Kalgoorlie who sustains their injury in Perth.

Table 3.1: Incidence of persisting SCI from traumatic causes by remoteness of residence and where injury occurred, Australia 2007–08 (case counts and row percentages)

	Remoteness area where injury occurred											
	Major cities of Australia		Inner regional Australia		Outer regional Australia		Remote Australia		Very remote Australia		All remoteness areas	
Remoteness area of patient residence	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**
Major cities of Australia	73	76	10	10	11	11	*	*	0	0	96	100
Inner regional Australia	9	21	27	63	5	5	0	0	*	*	43	100
Outer regional Australia	*	*	*	*	25	25	*	*	0	0	29	100
Remote Australia	*	*	0	0	0	0	8	8	*	*	10	100
Very remote Australia	0	0	0	0	0	0	*	*	9	9	10	100
All remoteness areas	**84**	**45**	**39**	**21**	**41**	**43**	**12**	**13**	**12**	**13**	**188**	**100**

* Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.



Note: Error bars indicate 95% confidence intervals for rates, based on Poisson distribution. Direct age standardisation was employed, taking the Australian population in 2001 as the standard.

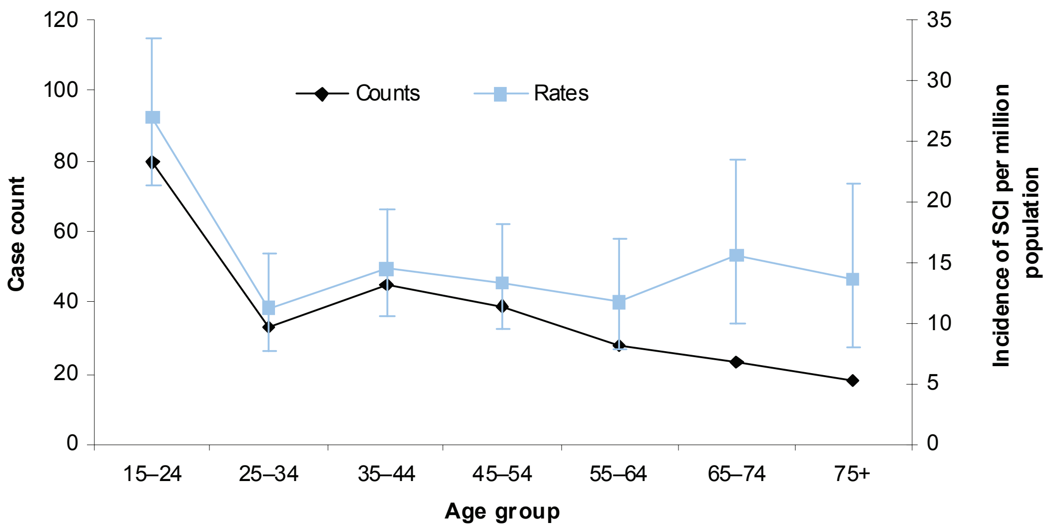
Figure 3.3: Incidence of persisting SCI from traumatic causes by remoteness of residence; Australia 2007–08 (aged 15 years and over)

3.4 Age and sex distribution

The age distribution of cases and rates of persisting SCI from traumatic causes is presented in Figure 3.4. Spinal cord injuries were most frequent in the 15–24 year age group, accounting for 30% (*n* = 80) of the cases of persisting SCI. The average age at injury was 41 years for males and 44 years for females. Since 1995 there has been a significant increase in the average age at injury from 38 years in 1995–96 to 42 years in 2007–08. This trend has been reported internationally (Jackson et al. 2004) and is likely to be a reflection of the ageing population.

Case counts for people aged 15–24 years increased markedly from 2006–07 with a rise in the incidence rate from 19.6 to 26.9 SCI per million population. Similarly, an increase in cases was seen in the 65–74 year age group resulting in a rise in the incidence rate from the 2006–07 report (11.2 to 15.6 SCI per million population). In the 25–34 year age category there was a decrease in the number of SCIs with a concomitant fall in the incident rate.

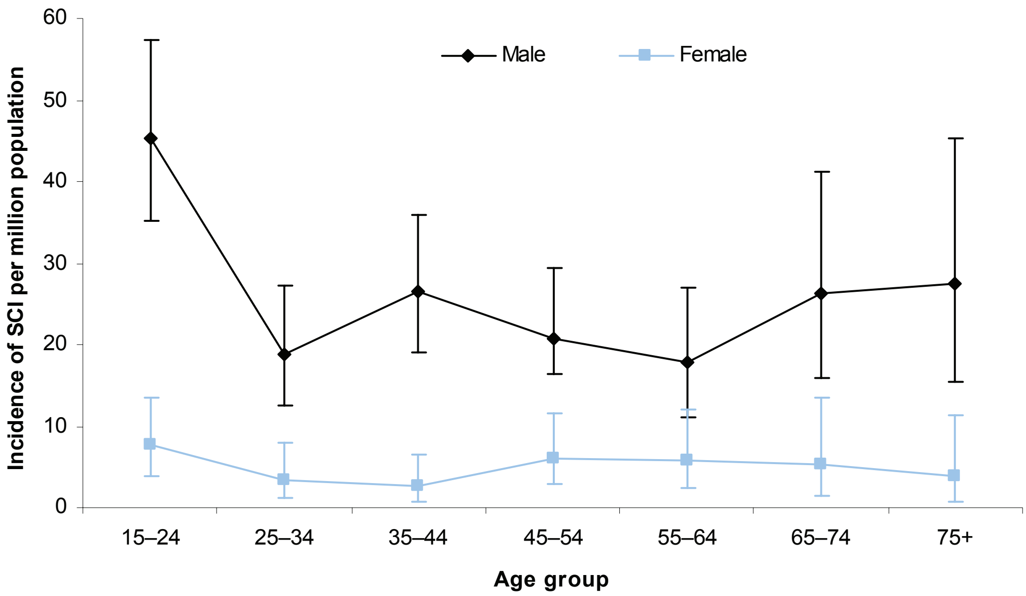
The 95% confidence intervals on the rates, based on the Poisson distribution, indicated that in 2007–08, age-specific rates were significantly higher for the 15–24 year age group compared to those aged between 25 and 64 years. However the confidence intervals overlap with those 65 years and over. The incidence rate was lowest (11.2 SCI per million population) among the 25–34 year age group with a gradually increasing incidence across the older age groups.



Note: Error bars indicate 95% confidence intervals for rates.

Figure 3.4: Incidence of persisting SCI from traumatic causes by age group, Australia 2007–08 (counts and age-specific rates)

The overall incidence rate for males was 26.4 compared to 5.0 for females, making the ratio of SCI 5.3:1 (males:females). This preponderance of males to females has been previously described both in Australia and internationally with male:female rate ratios reported between 2.5 and 5.8 (Wyndaele & Wyndaele 2006). The incidence rate for persisting SCI was higher for males across all the age groups compared to those for females (Figure 3.5) with the greatest difference seen in the 15–24 year age category.



Note: Error bars indicate 95% confidence intervals for rates.

Figure 3.5: Incidence of persisting SCI from traumatic causes by age group and sex, Australia 2007–08 (age-specific rates)

3.5 Socioeconomic characteristics

Spinal cord injuries have enormous health, social and economic impacts on individuals, families, and communities. As well as the physical and psychological impact on those affected directly by SCI, there is also a heavy burden on those involved with the victims. Family, friends and communities of those affected directly by SCI can also experience short- and long-term adverse social, physical and psychological outcomes. Socioeconomic factors that are known to be important in relation to injury and rehabilitation such as marital status, employment status and educational level attained (education status) at the time of onset of the SCI are recorded by the ASCIR and are presented as age-specific populations in Tables 3.2–3.4.

Forty-four per cent of the patients were married or in a de-facto relationship (Table 3.2). This is lower than the 61% of Australians over the age of 18 living in a couple relationship (either married or de-facto) reported in the 2006 Australian census (ABS 2009). Sixty-six per cent (n = 75) of the 'never married' group were young adults aged 15–24 years. Fewer patients were reported to be widowed, divorced or separated in 2007–08 compared to the 2006–07 reporting period (11% versus 17%, respectively).

Table 3.2: Marital status at onset of persisting SCI by age group: patients reported to ASCIR by spinal units; Australia 2007–08 (counts and column percentages)

	Age of the person with SCI at the time of admission							
	15–24		25–64		65 and older		All ages	
Marital status	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**
Never married	75	94	34	23	4	10	113	43
Widowed	0	0	*	*	8	20	10	4
Divorced	0	0	14	10	0	0	14	5
Separated	0	0	5	3	*	*	6	2
Married (including de facto)	*	*	86	59	28	68	117	44
Not stated/inadequately described	*	*	4	3	0	0	6	2
Group Total**	**80**	**100**	**145**	**100**	**41**	**100**	**266**	**100**

* Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.
**Totals include 6 cases where marital status was not stated, not reported or inadequately described.

Participation in the workforce pre-injury is an important predictor of post-injury employment (Pflaum et al. 2006). Sixty-one per cent of those who acquired persisting SCI were employed when their SCI occurred (Table 3.3). This reflects the annual average labour force participation rate in Australia, which was 64% in 2005–06 (ABS 2007). Patients in the 25–64 years age category had the highest workforce participation rate at 78%, reflecting the national average of 76% for those within the same age category.

Workforce participation declines with age, particularly after age 65 years. At age 65 years and older, a greater proportion of people acquiring SCI were employed compared to the national average for all Australians within this age category (22% versus 8%). Over half of the SCI among employed persons in this age category occurred while at work (56%). However, care should be taken when interpreting these results as case numbers are small.

Table 3.3: Employment status at onset of persisting SCI by age group: patients reported to ASCIR by spinal units; Australia 2007–08 (counts and column percentages)

	Age of the person with SCI at the time of admission							
	15–24		25–64		65 and older		All ages**	
Employment status	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**
Employed	50	63	104	72	9	22	163	61
Pensioner	*	*	12	8	29	71	42	16
Unemployed/not avail for employment/Not reported	29	36	29	20	*	*	61	23
Group Total	**80**	**100**	**145**	**100**	**41**	**100**	**266**	**100**

* Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.
** Employment status for 9 cases was not reported.

Overall, 30% of patients had a post-school qualification (Table 3.4). In the prime working ages of 25–64 years 34% had some form of further education, this is lower than the 59% of Australians reported to hold a post-school qualification in the *ABS Survey of education and work* in the same age category (ABS 2007). Twelve per cent had tertiary qualifications while 17% had a trade qualification compared to 24% and 39%, respectively, for the general population aged 25–64 years.

Table 3.4: Educational level attained at onset of persisting SCI by age group: patients reported to ASCIR by spinal units; Australia 2007–08 (counts and column percentages)

	Age of the person with SCI at the time of admission							
	15–24		25–64		65 and older		All ages	
Education status	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**
Tertiary/post graduate	*	*	18	12	*	*	22	8
Trade qualification/apprentice	15	19	25	17	7	17	47	18
Diploma or certificate	*	*	6	4	*	*	8	3
Other post school study	*	*	0	0	*	*	*	*
Highest available secondary school level	19	24	34	23	10	24	63	24
Left school aged 16 or over	9	11	13	9	*	*	23	9
Left school aged 15 or less	4	5	13	9	6	15	23	9
Never attended school	0	0	0	0	0	0	0	0
Still at school	15	19	*	*	0	0	17	6
Not reported	14	18	34	23	13	32	61	23
Group Total	**71**	**100**	**145**	**100**	**41**	**100**	**266**	**100**

* Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.

Higher education greatly increases the likelihood of employment post-injury (Pflaum et al. 2006) although employment rates are also influenced by the level of SCI, age, marital status and pre-injury employment. A number of studies in the USA, Europe and Australia have reported return to paid employment ranging between 11.5% to 71% (Krause 2003; Valtonen et al. 2006; Young et al. 2004) with an average return to work rate of 44% (Lidal et al. 2007).

4 Clinical characteristics of persisting SCI cases

The monitoring of clinical information on SCI enables the patients' outcomes in response to treatment to be studied. It also indirectly provides an indication of the degree of support required by this population at discharge from hospital. Information on the neurological level of SCI, extent of injury to the cord, and the degree of impairment is routinely reported by SUs during the initial hospitalisation for the SCI, and at discharge from rehabilitation.

As in the previous section, discussion of clinical features of SCI is based on persisting SCI cases (i.e. people who are Australian residents who sustained their incident SCI injury in 2007–08 from traumatic causes, in Australia or overseas, and had an ASIA Impairment Scale score of A to D).

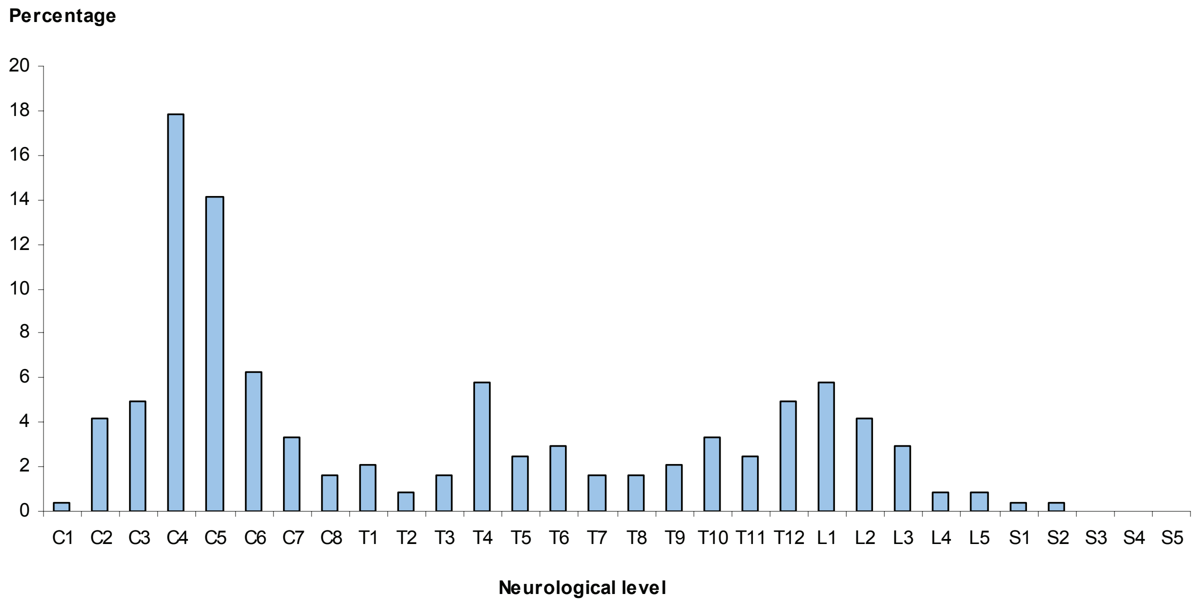
During 2007–08, 266 SCI cases admitted to SUs met this definition. Of these 266 cases, 23 cases were still inpatients at the time of extracting data for this report and 2 cases had no documentation of their neurological level of injury at discharge.
The 241 cases for whom information on neurological level and extent of injury are known to meet the register's definition of 'persisting SCI' will be the focus of the first two parts of this section of the report. The duration of initial care (DIC) values presented in Section 4.3 are based on persisting SCI cases *discharged* during 2007–08 who had their injury prior to (n = 114) or during the 2007–08 reporting period (n = 150).

4.1 Neurological level of injury

The distribution of neurological level of persisting SCI at discharge is presented in Figure 4.1). A significant proportion of cases admitted to SUs had SCIs involving the cervical segments (53%, n = 127). This type of impairment is referred to as *tetraplegia*. (Injury at the thoracic, lumbar or sacral level is termed *paraplegia*.) Over the past eight years cervical spine injuries have accounted for between 50% and 59% of all SCI. The most common cervical spine injuries involved C4–C5. This group accounted for 61% of cervical SCI cases and 32% of all documented neurological injuries reported in 2007–08.

The next most common neurologic level of injury was at the thoraco-lumbar junction with 11% of cases reporting neurological impairment at T12/L1 (n = 26).

Injuries to the thoracic spine accounted for 32% (n = 77) of all injuries reported. The number of thoracic spine injuries has ranged between 64 in 2003–04 to a high of 93 in 2004–05 with, on average, 31% of SCI documented at this level annually since 2000–01. Lumbar and sacral injuries make up the remaining cases.



Note: n = 241 cases.

Figure 4.1: Incidence of persisting SCI from traumatic causes by neurological level at discharge; Australia 2007–08 (percentages)

4.2 Neurological category

The overall severity of SCI is usually measured by a combination of the neurological level of injury (tetraplegia or paraplegia) and extent of injury (complete or incomplete) and is divided into five neurological categories (complete tetraplegia, incomplete tetraplegia, complete paraplegia, incomplete paraplegia, and complete recovery). Table 4.1 presents the counts and table percentages for the four neurological categories relevant to a discussion of persisting cases of SCI, based on all cases with neurological levels and extent of injury reported (241 cases).

In 2007–08 a greater proportion of incomplete SCI cases were recorded (65%). The 241 patients with a persisting SCI analysed here were most likely to have incomplete tetraplegia injuries (38%), followed by incomplete paraplegia (27%), complete paraplegia (20%) and complete tetraplegia (15%). This distribution of neurological injury patterns is relatively consistent from year to year.

Similar results have been found in Europe (Dahlberg et al. 2005; van Asbeck et al. 2000) although this differs from the United States where reports describe greater proportions of complete SCI cases, associated with a higher proportion of penetrating gunshot injuries (Jackson et al. 2004).

Table 4.1: Incidence of persisting SCI from traumatic causes by neurological level (major grouping) and extent of injury; Australia 2007–08 (counts and table percentages)

Extent of injury	Tetraplegia		Paraplegia								Total	
	Cervical		Thoracic		Lumbar		Sacral		All paraplegia			
	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent
Complete	35	28	46	60	*	*	0	0	49	43	84	35
Incomplete	92	72	31	40	32	91	*	100	65	57	157	65
Total	**127**	**100**	**77**	**100**	**35**	**100**	*	**100**	**114**	**100**	**241**	**100**

* Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.

4.3 Duration of initial care

Length of stay (LOS) is a common index used in hospital and health reports and is typically defined as the time between the patient's admission, either to the hospital or a specific unit, until their discharge from the hospital or unit. Length of stay can be used as a marker of the level of care required by the patient and may reflect the severity of an injury or illness for specific conditions. However, not all SCI cases are admitted directly to a SU immediately following their SCI. They may be admitted to critical care units or hospital wards prior to their transfer to the SU. For example, traumatic SCI cases suffering life threatening injuries may receive multi-disciplinary treatment in critical care units until their condition allows their transfer to the SU. Similarly, patients may suffer a SCI a considerable distance from a SU and require treatment in a closer hospital prior to transfer to the nearest SU. To capture data on the patients entire experience from injury, including retrieval of the patient from the scene of the accident; stabilisation in a hospital or critical care unit; acute care in a SU and other wards; rehabilitation and to final discharge, the *duration of initial care* (DIC) has been used. The DIC is calculated from the period of time from the date of injury to the date of discharge from the SU to another hospital, home, nursing home or other accommodation. This differs from DIC calculations in the reports prior to 2006, which excluded patients discharged from spinal units to other hospitals. Patients who died while inpatients are not included in the DIC calculation.

In 2007–08 111 (42%) cases were admitted to SUs within 1 day of their SCI. However, 155 patients were admitted to other hospitals or specialist units immediately following their SCI and were transferred to the SU on average 26 days following injury (median = 16 days, interquartile range 6–33 days). Of these, nine Australians incurred their SCI overseas and spent on average 55 days in overseas hospitals prior to transfer to an Australian SU (median overseas hospitalisation = 32 days, interquartile range 16–97 days). When this report was prepared (March 2009), 243 of the 266 cases of persisting SCI incidents admitted in 2007–08 had been discharged from SUs after completing rehabilitation (23 cases were still inpatients).

The DIC calculation here includes persisting SCI cases that were admitted and discharged from spinal units during the 2007–08 reporting period (156 cases) and 89 cases that had a SCI prior to the 2007–08 reporting period but were discharged in this reporting period, a total of 245 cases.

Information on the duration of initial care in hospital from the date of injury to the date of discharge from the SU, by neurological category, is presented in Table 4.2. The *median* duration of initial care (MDIC) is reported to reduce the effect of outliers.

Table 4.2: Neurological status of injury to the spinal cord of cases of persisting SCI from traumatic causes for age groups discharged during 2007–08 in Australia (counts and median duration of initial care (MDIC))

	Tetraplegia		Paraplegia									
	Cervical		Thoracic		Lumbar		Sacral		All paraplegia		Total	
Extent of injury	Count	MDIC (days)	Count	MDIC (days)	Count	MDIC (days)	Count	MDIC (days)	Count	MDIC (days)	Count	MDIC (days)
Complete	42	221	50	151	6	93	0	0	56	144	98	177
Incomplete	85	117	29	133	30	105	*	*	62	111	147	112
Total	**127**	**150**	**79**	**139**	**36**	**102**	*****	*****	**118**	**115**	**245**	**133**

* Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.

Duration of initial care can vary according to the extent and neurological level of injury to the cord as well as other factors such as patient co-morbidities, other injuries sustained at the time of the accident and the health and age of the patient. In addition, the discharge process after completion of rehabilitation may be prolonged due to the lack of suitable accommodation or trained carer availability for some patients, further increasing the duration of care.

The MDIC for all persisting cases of SCI discharged during 2007–08 (245 cases) was 133 days, ranging from a high of 221 days for cases of complete tetraplegia to 77 days for cases of incomplete paraplegia involving injury to sacral spinal segments (Table 4.2).

Patients with tetraplegia had a longer MDIC than those with paraplegia (30% greater overall). For patients with paraplegia, the longest MDIC was reported for those with complete injury to the thoracic spinal segments (151 days).

For tetraplegic patients, the 5th and 95th percentiles of length of stay were 15 and 397 days compared to 13 and 315 days for paraplegic cases (Table 4.3). The longest MDIC occurred while treating patients with complete tetraplegia (221 days). The 5th and 95th percentiles for duration of initial inpatient treatment for this group were 123 days and 397 days, illustrating the effect of patient case mix, small numbers at spinal units, as well as other factors mentioned above, on MDIC. For this reason, utilisation of national MDIC data for benchmarking purposes at the state level should be made with caution.

Table 4.3: Neurological category of injury to the spinal cord of cases of persisting SCI from traumatic causes for age groups discharged during 2007–08 in Australia (median duration of initial care (MDIC) and percentiles [5th and 95th])

	Tetraplegia				Paraplegia			
Extent of injury at discharge	Count	Median	5th Percentile	95th Percentile	Count	Median	5th Percentile	95th Percentile
Complete	42	221	123	397	56	144	71	315
Incomplete	85	117	15	303	62	111	13	263
Group Total	**127**	**150**	**18**	**336**	**118**	**115**	**18**	**301**

5 Factors associated with the SCI event

In addition to collecting information on the incidence of SCI, the ASCIR also collects information about the event which resulted in the injury, such as the mechanism of injury, the role of human intent, the type of place where the injury occurred, and the type of activity involved in at the time of injury. This information, obtained from case registration forms of all incident SCI cases from traumatic causes aged 15 years and older (n = 285, i.e. the 266 cases discussed in the previous sections plus 19 cases with either no neurological deficit at discharge, who died while in hospital or were non-residents of Australia) and coded according to the NISU's National Data Standards for Injury Surveillance (NDS-IS), helps to improve understanding of the underlying events that led to the injury.

In this report, mechanisms of injury are described in Section 5.1 and activities being undertaken at the time of injury in Section 5.2. The latter section includes a cross-tabulation of mechanism by activity. Aggregation of cases coded to the NDS-IS into mechanism of injury categories used in Sections 5.1 and 5.2 is described in the Appendix.

5.1 Mechanism of injury

The mechanisms of injury for incident cases of SCI from traumatic causes are shown in Table 5.1. Transport incidents accounted for 46% (n = 130) of SCI cases in 2007–08. Similarly, Henley (2009) found that 47% of incident SCI cases admitted to Australian hospitals between 1999 and 2005 were as a result of transport accidents. Transport incidents have been segmented into traffic or non-traffic categories depending on where the incident occurred (see Table A1.1) and whether the person was a motor vehicle occupant or unprotected road user. Of all transport cases, 78% (n = 101) occurred on public roads (i.e. traffic) while 22% (n = 29) occurred in non-traffic situations. Fifty one per cent (n = 66) were motor vehicle occupants and 49% (n = 64) were unprotected road users.

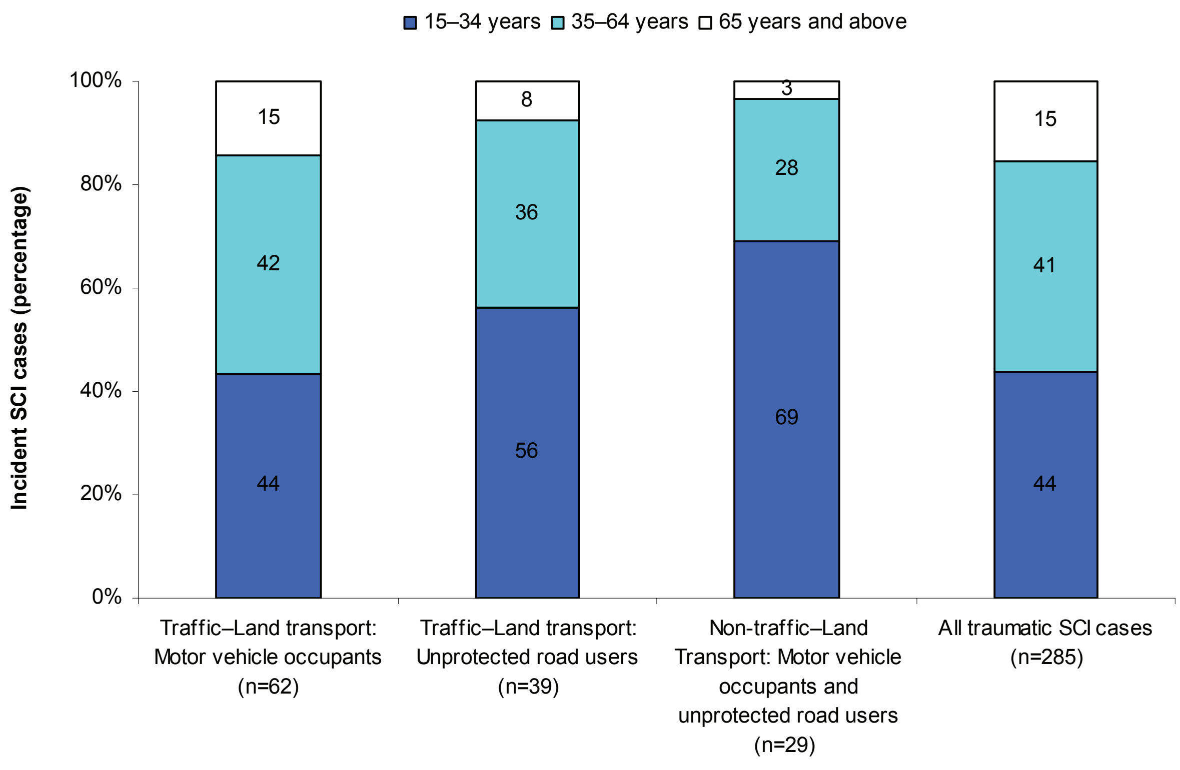
Injuries sustained from falls accounted for 28% (n = 81) of cases. Injuries associated with swimming, diving, surfing or falling into water contributed 9% (n = 27) of cases. While injuries attributed to being struck or colliding with an object or person accounted for a further 9% of cases.

Mechanism of injury by age group is presented in figures 5.1 (transport incidents), 5.2 (falls) and 5.3 (all other mechanisms). Cases are described by mechanism of injury and neurological level of injury in Table 5.2 and mechanism of injury and activity at the time of injury in Table 5.3.

Table 5.1: Incidence of SCI from traumatic causes by mechanism of injury; Australia 2007–08 (counts and column percentages)

Mechanism	Counts	Per cent
Traffic—Land transport: Motor vehicle occupants	62	22
Traffic—Land transport: Unprotected road users	39	14
Non-traffic—Land transport: Motor vehicle occupants	4	1
Non-traffic—Land transport: Unprotected road users	25	9
Low falls	29	10
High falls	52	18
Struck by or collision with a person or object	25	9
Water-related	27	9
Other	22	8
Total	**285**	**100**

A comparison of the incidence of SCI from traffic and non-traffic land transport accidents by age group is shown in Figure 5.1. The *Non-traffic* categories of *motor vehicle occupants* and *unprotected road users* have been combined because of low numbers.



Note: Numbers shown in the bars are percentages.

Figure 5.1: Incidence of SCI from traffic and non-traffic land transport accidents by age group, Australia 2007–08 (percentages of each group)

5.1.1 Traffic—Land transport: Motor vehicle occupants

Motor vehicle occupants are defined as either a driver or passenger of a motor vehicle. Twenty-two per cent (*n* = 62) of all SCI were attributed to motor vehicle occupants involved in traffic incidents. The majority of motor vehicle occupants were male (79%, *n* = 49). The age breakdown for this category closely resembled that for all SCI with 44% (*n* = 27) in the 15–34 years age range and 42% (*n* = 26) in the 35–64 years age range (Figure 5.1). The motor vehicle occupants category had the highest proportion of people aged 65 years or older (15%, *n* = 9) and most were drivers (89%, *n* = 8) rather then passengers.

The most common type of event was a vehicle rollover, accounting for 52% (*n* = 32) of motor vehicle occupants SCI. This trend has been apparent in the previous two reports. Impact with a roadside hazard was the next most commonly reported contributing event (*n* = 24) while impact with a motor vehicle was reported in 21% (*n* = 13) of SCI cases. These contributing events are not mutually exclusive so it was possible for a number of events to be recorded as contributing to the incident, for example, a collision between two motor vehicles could have also resulted in a motor vehicle rollover and both events would be reported in the patient's records. Of the rollover incidents, ten (32%) reported impacting a roadside hazard and two (6%) reported impact with another vehicle prior to the rollover. For non-rollover motor vehicle occupant cases (*n* = 28), impact with another vehicle was reported in 39% (*n* = 11) of the accidents, 50% (*n* = 14) involved an impact with a roadside hazard. Note, in two cases there was insufficient data for the SU to determine if a rollover had occurred.

The use of seat belts was reported in 47% of land transport traffic accidents. In SCI cases where the occupant was ejected from the motor vehicle (*n* = 11) none were reported to have been wearing a seat-belt. Alcohol use was reported in 8% (*n* = 5) of traffic land transport accidents however this variable was poorly documented in the data with alcohol use recorded as unknown or left blank in 71% of cases.

The mechanisms of injury in motor vehicle accidents, that is, as a result of the transfer of high mechanical or kinetic energy to occupants may result in high severity of injury to many body regions, in addition to the spinal column. Nearly two-thirds (60%) of the motor vehicle occupants group had additional injuries as well as their spinal cord injury. Head injuries, including facial lacerations, fractures and traumatic brain injuries, accounted for 11% (*n* = 7) of these, while injuries to the thorax (e.g. fractured ribs and sternum, pneumothorax and pulmonary contusion) accounted for a further 11% (*n* = 7). Injuries to the abdominal organs, pelvis and fractures to the extremities were also reported. Sixteen cases were documented with multi-trauma involving both head and chest or head and extremity injuries.

Forty-eight per cent (*n* = 30) of the cases in the motor vehicle occupants group sustained injuries to the cervical spinal segments resulting in tetraplegia (Table 5.2) while 34% sustained injuries to the thoracic or lumbar spine (*n* = 14 and 7 respectively).

In cases involving rollover (*n* = 32), 44% (*n* = 14) of the occupants had injury to the cervical segments of the cord resulting in tetraplegia. Thirty-six per cent (*n* = 5) of these cases resulted in complete tetraplegia. A further 13 had injury to the thoracic and lumbar spinal segments resulting in paraplegia and 38% of these cases had complete injury to the cord resulting in complete paraplegia. Four cases had no neurological level of injury reported while one case had no persisting SCI at discharge.

5.1.2 Traffic—Land transport: Unprotected road users

Unprotected road users are users of land transport without the protection of a structure such as a car body. They include motorcyclists (drivers or pillion passengers), pedal cyclists and pedestrians and account for 14% (n = 39) of all traffic related cases of SCI during 2007–08 (Table 5.1).

The vast majority of unprotected road users were male (92%, n = 36), and they tended to be younger with over half (56%, n = 22) in the 15–34 years age group. This is notably higher than both the 2006–07 report (which reported 43% of traffic related unprotected road users in this age group), and for all traumatic SCI cases in the current reporting period (44%, n = 125). Only 8% (n = 3) of unprotected road user cases were 65 years or older (Figure 5.1) and this is the same as previous years.

As in previous years, motorcyclists accounted for the majority of the unprotected road users group. Of the 39 cases, 31 (79%) were motorcyclists, 4 (10%) were pedal cyclists and 4 (10%) were pedestrians. Sixty-one per cent of the motorcycle related SCI were in the 15–34 years age group (n = 19), while 50% of pedestrian and 25% of pedal cycle cases were in the same age grouping.

Use of protective devices was reported for over half of the unprotected road users, 57% (n = 20) of motor and pedal cyclists had used a helmet (pedestrians were not included here). Impact with a motor vehicle and impact with a roadside hazard were documented in 35% (n = 13) and 44% (n = 16) of unprotected road users, respectively.

Additional injuries were documented for 23 (59%) of the unprotected road users. Motorcyclists, accounted for 83% (n = 18) of the additional injuries. Multi-trauma was documented in 33% (n = 6) of motorcyclists and 50% (n = 2) of pedal cyclists. Thoracic injuries (fractured ribs and sternum, pericardial effusion, lung contusions, haemothorax and pneumothorax) predominated and head injuries were less common, 25% (n = 1) of pedestrians and 22% (n = 4) of motorcyclists.

In the unprotected road user, injuries to the thoracic spine were the most common (51%, n = 20), followed by cervical injuries (28%, n = 11). Neurological level of injury was not reported or unavailable for 5 cases (Table 5.2).

Forty-four per cent (n = 17) of SCI cases in 2007–08 among unprotected road users in traffic incidents had a complete lesion of the spinal cord. Thirteen of these 17 cases (76%) involved motorcyclists or their passengers.

5.1.3 Non-traffic—Land transport

Non-traffic land transport related accidents occurred primarily off-road on trail or mountain bike tracks, beaches, farms and other undeveloped recreational areas (n = 29). Nearly half of all non-traffic land transport cases were in people under 25 years of age (n = 14) and a further 21% (n = 6) were 25–35 years of age. This has resulted in a substantially greater proportion of younger people in this category (69%, n = 20) than for all traumatic SCI cases (Figure 5.1) and in previous years (e.g. 50% of non-traffic land transport in 2006–07).

Eighty-six per cent (n = 25) of the non-traffic land transport group were unprotected road users. Seventy-six per cent (n = 19) of the unprotected road users were motorcyclists, 16% (n = 4) were pedal cyclists and the remainder (n = 2) were pedestrians or drivers of a motorised transport device (quad bike). Four motor vehicle occupants (14%) sustained their SCI in non-traffic incidents.

The age profile for non-traffic land transport motorcyclists differed from that of traffic land transport motorcyclists with nearly twice as many motorcyclists aged 15–24 years in the non-traffic group than the traffic group (58% versus 26%). This trend is typical as younger motorcyclists can access off-road trails while too young to ride legally on public roads.

Over half of the motor- and pedal-cyclists in the non-traffic land transport group used a helmet, (n = 13—motor vehicle occupants were excluded here). No additional injuries were reported for 54% (n = 14) of the non-traffic land transport cases. However, of those cases that did have additional injuries, multi-trauma, (n = 5) and injuries to the extremities, (n = 3), and thorax, (n = 3) were reported.

For the non-traffic land transport group, thoracic spine injuries accounted for 45% (n = 13) of cases followed by cervical injuries (33%, n = 10) (Table 5.2). Fifty-two per cent (n = 15) of 2007–08 cases of SCI among the non-traffic group had complete lesion of the spinal cord, 13 of these were amongst the motorcyclists. One case had no neurological level of injury recorded by the SU at the time this report was written.

Table 5.2: Incidence of persisting SCI from traumatic causes by mechanism of injury and neurological level of injury 90 days post admission or at discharge; Australia, 2007–08 (counts and row percentages)

	Neurological level 90 days post admission or at discharge																	
	Tetraplegia		Paraplegia															
	Cervical		Thoracic		Lumbar		Sacral		All paraplegia		No neurological injury		Neurological level not available from SU		Neurological not reported		Group Total	
Mechanism	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent
Traffic—Land transport: Motor vehicle occupants	30	48	14	23	7	11	0	0	21	34	0	0	*	*	10	16	62	100
Traffic—Land transport: Unprotected road users (motor cyclists, pedal cyclists, pedestrians)	11	28	20	51	*	*	0	0	23	59	0	0	0	0	5	13	39	100
Non-traffic—Land transport: Motor vehicle occupants	*	*	*	*	*	*	0	0	*	*	0	0	0	0	0	0	4	100
Non-traffic—Land transport: Unprotected road users (motor cyclists, pedal cyclists, pedestrians)	8	32	12	48	*	*	*	*	16	64	0	0	0	0	*	*	25	100
Low falls	21	72	*	*	5	17	0	0	8	28	0	0	0	0	0	0	29	100
High falls	26	50	13	25	9	17	0	0	22	42	0	0	0	0	4	8	52	100
Struck or collision by person or object	9	36	7	28	*	*	*	*	9	36	0	0	*	*	6	24	25	100
Water-related	26	96	0	0	0	0	0	0	0	0	0	0	0	0	*	*	27	100
Other	*	*	9	41	6	27	0	0	15	68	0	0	0	0	4	18	22	100
All mechanisms	**136**	**48**	**79**	**28**	**35**	**13**	*	**1**	**116**	**41**	**0**	**0**	*	**1**	**31**	**11**	**285**	**100**

* Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.

5.1.4 Falls

Falls, both low (on the same level, or from a height of less than 1 metre) and high (from a height of 1 metre or more), accounted for 28% (*n* = 81) of SCI cases during the 2007–08 reporting period (Table 5.1).

In 2007–08, low falls (*n* = 29) were more common in those aged 35–64 years (55%, *n* = 16), followed by those over 65 years of age (41%, *n* = 12). High falls (*n* = 52) were also more common in the 35–64 year age group (48%, *n* = 25) however this was followed by those aged 15–34 years (38%, *n* = 20) (Figure 5.2).

Fifty-two per cent of low falls (*n* = 15) occurred in the patient's home while they were doing personal activities or as a result of medical conditions (dizziness or cardiovascular conditions). Alcohol consumption or intoxication was reported in 8 low fall cases.

Half of the low falls that occurred in people aged 65 and older (*n* = 6) were associated with slips and trips that occurred in or around their own home. Seventeen per cent (*n* = 2) were as a result of a medical condition.

Low falls, with cervical spine injuries, resulted in tetraplegia in 72% of cases (*n* = 21) (Table 5.2). Paraplegia was less common (*n* = 8) and involved injury to the thoracic and lumbar spine. Among those aged 65 years and older, tetraplegia occurred in 75% (*n* = 9) of cases with an incomplete injury to the cervical spine in all but one of the cases.

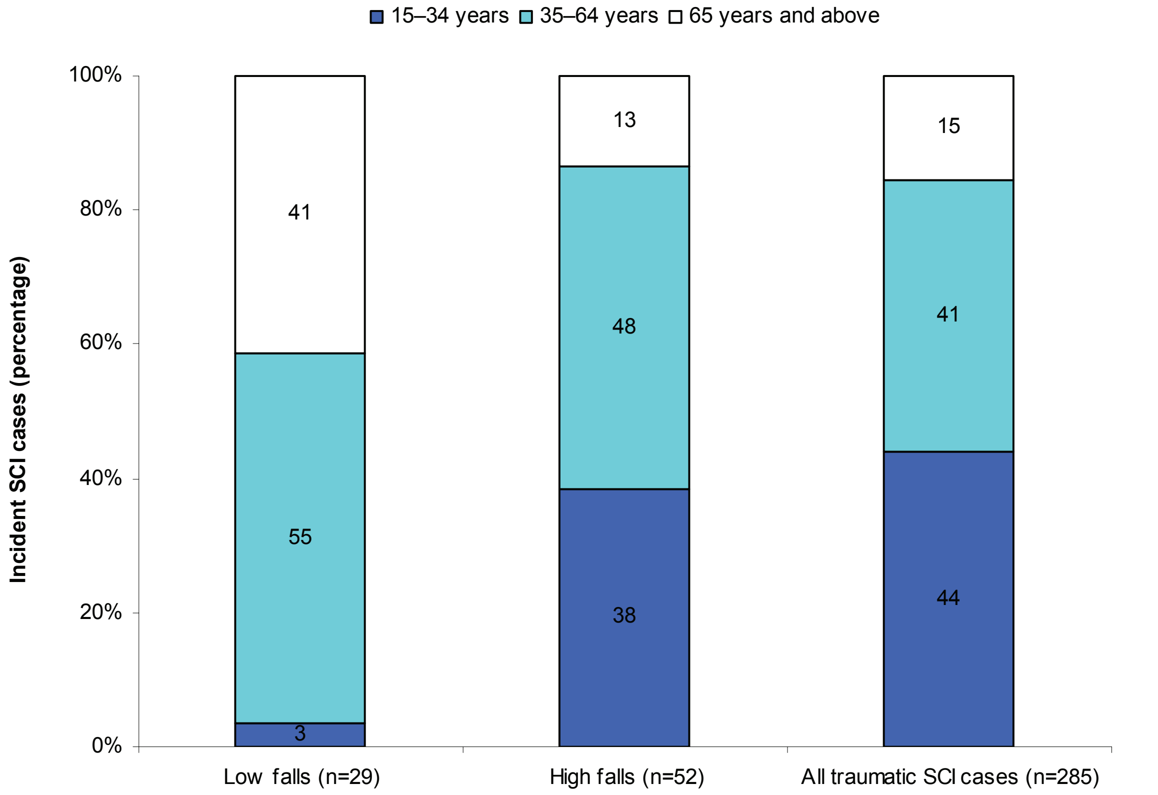
Sixty-four per cent (*n* = 52) of the injurious falls were from a height of 1 metre or more. This is notably higher than in 2006–07 (*n* = 38) although similar to preceding years (*n* = 60 in 2005–06; *n* = 53 in 2004–05; *n* = 57 in 2003–04). Eighty-seven per cent of those whose injury resulted from falling from a height were aged between 15–64 years, compared with 58% of those involved in low falls (Figure 5.2).

Seventeen per cent (*n* = 9) of high falls occurred while working for income using ladders or scaffolding on building sites, during construction work, cutting trees, or working on transport vehicles. This is similar to the 2006–07 (*n* = 8) report and both were lower than for 2005–06 when 18 such cases were reported.

A further 17% of high falls (*n* = 9) involved activity which can be described as work, but not for income, such as doing handyman jobs around the home. Falls from ladders or scaffolding occurred in over half of the 'handyman' type incidents (*n* = 5). This reflects the findings of Bradley (2007) which indicated that a large proportion of falls from ladders occurred at home and while engaged in 'other types of work'.

Leisure and sporting activities accounted for 19% (*n* = 10) of the high fall cases. Alcohol consumption or intoxication was reported in 13% (*n* = 8) of cases involving high falls.

Falling from a height resulted in tetraplegia in 50% of the cases (*n* = 26) and paraplegia in 42% (*n* = 22) of the cases (see Table 5.2). These proportions differ from the results reported in 2005–06 and 2006-07 when a greater proportion of paraplegia was documented. Sixty-three per cent (*n* = 33) of the cases resulting from high falls had an incomplete lesion of the cord and 29% had complete lesion of the cord. Of the remaining 8% of cases (*n* = 4), no extent of injury was reported at the time of writing this report.



Note: Numbers shown in the bars are percentages.

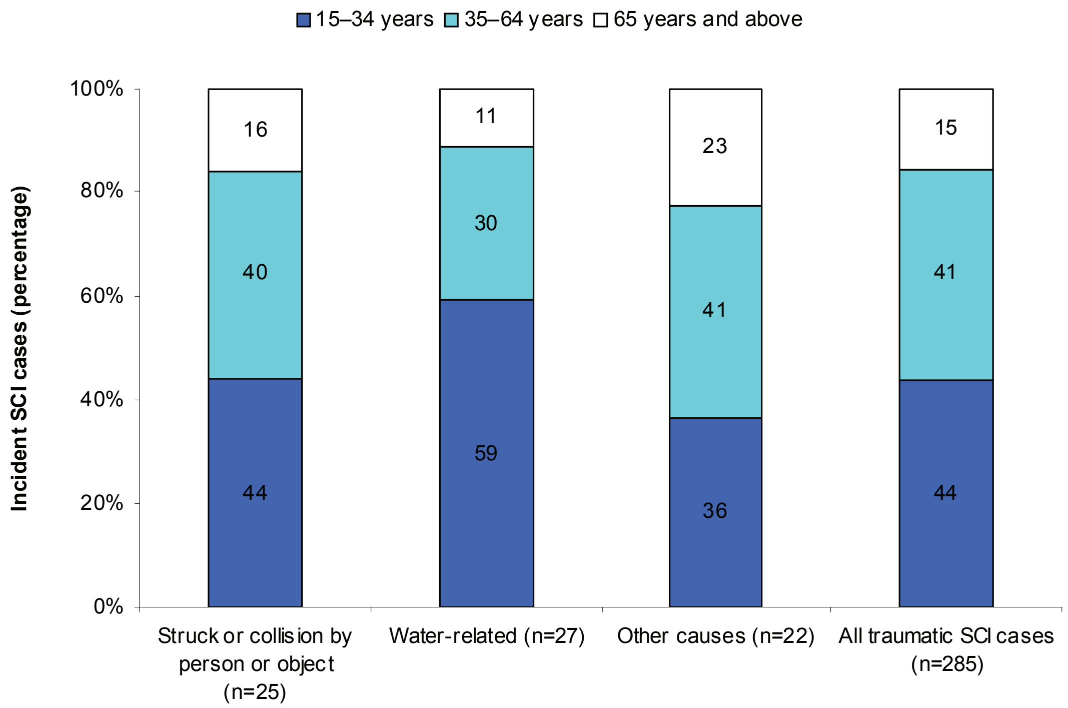
Figure 5.2: Incidence of persisting SCI from low and high falls by age group, Australia 2007–08 (percentages of each group)

5.1.5 Struck by or collision with a person or object

Nine per cent (*n* = 25) of the SCI cases reported during 2007–08 were the result of being struck by, or collision with, a person or an object (Table 5.1). The age breakdown for SCIs in this category was similar to the age breakdown for all traumatic SCIs with 44% (*n* = 11) in the 15–34 year age group followed by 40% (*n* = 10) in the 35–64 year age group and 16% (*n* = 4) over 65 years of age (Figure 5.3).

Forty per cent (*n* = 10) of SCI cases in this category occurred as a result of contact with the ground or another person while participating in sporting or leisure activities. A further 36% (*n* = 9) of the injuries occurred when the person was undertaking paid employment and was struck by falling objects or machinery. In the remaining cases, injury resulted while performing home handyman activities (*n* = 4) or as a result of assault (*n* = 2).

Thirty six per cent of the cases (*n* = 9) had injury to the cervical spinal segments and nine of the remaining 16 cases had injuries to the thoracic, lumbar and sacral spinal segments (Table 5.2). Thirty-six per cent (*n* = 9) had complete lesion of the cord, similarly 36% (*n* = 9) had incomplete lesion of the cord. In seven cases the neurological extent of injury was not reported at the time of writing this report.



Note: Numbers shown in the bars are percentages.

Figure 5.3: Incidence of persisting SCI from being hit or struck by an object, diving or surfing, and other accidents by age group, Australia 2007–08 (percentages of each group)

5.1.6 Water-related

Water-related accidents accounted for 9% (*n* = 27) of the SCI cases reported during 2007–08 (Table 5.1) and 59% (*n* = 16) of these cases occurred in people under the age of 35 years (Figure 5.3).

All of the reported water-related SCI cases involved injury to the cervical spinal segments (Table 5.2), with two-thirds of these cases (*n* = 17) sustaining an incomplete injury to the cord. Sixty-three per cent of the injuries (*n* = 17) were the result of people diving or falling into a body of water. Six injuries occurred in swimming pools, 15 in the ocean and five on rivers. About a fifth (19%, *n* = 5) related specifically to surfing or body surfing.

5.1.7 Other causes

Eight per cent of the SCI cases (*n* = 22) reported during 2007–08 had an external cause of injury that was not included in the other major groups of external causes detailed in Table 5.1. These other external causes of injury to the spinal cord included injuries from shooting and stabbing, complications of medical treatment, being crushed by or lifting heavy objects, air crashes and decompression sickness following SCUBA diving.

Sixty-eight per cent of SCI cases in the *Other causes* group sustained injury to the thoracic and lumbar spinal segments resulting in paraplegia (*n* = 15) and three cases had injury to cervical spinal segments (14%). Most cases (*n* = 13, 59%) had an incomplete SCI. The neurological level of injury was not reported for four cases at the time of writing this report.

5.2 Type of activity at time of injury

Information on underlying events is intended to assist in setting priorities for prevention and in the development and implementation of injury prevention interventions to reduce the incidence of SCI in Australia.

Activity at the time of injury was obtained from structured injury narratives of all traumatic cases of SCI reported during 2007–08 which were coded according to the NDS-IS, Level 1 activity categories (*n* = 285). These categories, together with the mechanism of injury and the place at which injury occurred, allowed cases to be grouped into categories so that sectors with relevant responsibility and authority can be identified and targeted for injury prevention. Table 5.3 details these mechanisms of injury, and the activity being undertaken at the time of the injury.

Eight per cent of the SCI cases (*n* = 22) occurred during sporting activities, and 73% of these occurred in people under the age of 35 years. SCIs occurred across a range of sporting activities, including motorised sports (trail bike and motocross racing) (45%), the major football codes (25%), pedal cycle races (9%) and horse-related activities (9%).

Fifty per cent of the SCIs from sporting activities occurred to the cervical spinal segments resulting in tetraplegia, with incomplete lesion of the cord occurring in 64% of these cases.

All five cases of SCI which occurred during football games were as a result of direct contact between the patient's head and/or shoulders and another player. Cervical spine injuries were recorded in four of these cases, no neurological level of injury was documented for the remaining case at the time of this report.

For motorised sports (*n* = 10), half of the cases involved injury to the cervical spine, 4 cases had injury to the thoracic spine and the remaining case had injury to the lumbar spine. Half of these motorised sports cases had complete lesion of the cord.

In the other sports-related cases (*n* = 7), 43% (*n* = 3) involved injury to the cervical spinal segments, 4 cases involved injury to the thoracic spinal segments and the remaining case involved injury to the lumbar spine.

Intentionally diving or jumping into bodies of water (*n* = 19), and surfing (*n* = 4) or surf related incidents (*n* = 4) resulted in SCI in over half of the leisure related cases (Table 5.3). Falls from trees, balconies, walls and on the same level (trips and stumbles) accounted for a further 25% (*n* = 12). Alcohol consumption or intoxication was documented in eight of the leisure related SCI.

Eighty-three per cent of the SCI attributed to leisure activities resulted in injury to the cervical spinal segments (*n* = 40). Three cases had no neurological injury status reported at the time of writing this report.

Injury to the spinal cord while working for income was also common, accounting for 14% (*n* = 39) of the cases. The average age of SCI cases that were work related was 45 years (S.D. = 15) with 46% under the age of 45 years. Transport incidents accounted for 44% of work related injuries followed by high falls from ladders, trees, scaffolding, and rooves (23%) and being struck by an object such as machinery, building materials or tree branches (23%).

Table 5.3: Incidence of SCI from traumatic causes by mechanism of injury and activity; Australia 2007–08 (counts and column percentages)

	Sports		Leisure		Working for income**		Other type of work		Personal activity		Other***/ Unspecified		Not reported		Group total	
Mechanism	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**	**Count**	**Per cent**
Traffic—Land transport: Motor vehicle occupants	0	0	*	*	10	26	0	0	0	0	51	34	0	0	62	22
Traffic—Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	*	*	*	*	*	*	0	0	0	0	33	22	0	0	39	14
Non-traffic—Land Transport: Motor vehicle occupants and unprotected road users	10	45	0	0	5	13	0	0	0	0	14	9	0	0	29	10
Low falls	0	0	4	8	0	0	*	*	9	82	14	9	0	0	29	10
High falls	*	*	8	17	9	23	9	56	*	*	23	15	0	0	52	18
Struck by or collision with a person or object	6	27	4	8	9	23	4	25	0	0	*	*	0	0	25	9
Water-related	0	0	27	56	0	0	0	0	0	0	0	0	0	0	27	9
Other	*	*	*	*	4	10	*	*	*	*	12	8	0	0	22	8
All mechanisms	**22**	**100**	**48**	**100**	**39**	**100**	**16**	**100**	**11**	**100**	**149**	**100**	**0**	**0**	**285**	**100**

* Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.
** Includes travel to and from work.
*** Includes Being nursed or cared for (n = 9).

Eight of the 13 work related cervical spine injuries occurred amongst motor vehicle drivers. Falls at work were responsible for thirty per cent of thoracic and lumbar spine work related injuries. Forty-four per cent of work related incidents resulted in incomplete paraplegia. Eighteen per cent resulted in complete paraplegia and incomplete tetraplegia each while complete tetraplegia occurred in 15% of work related SCI. Two cases had no neurological level of injury reported.

SCI occurred in 16 cases while people were working, but not for income. The average age for this group was 56 years (S.D. = 14.5). These injuries occurred primarily around the home (63%) during 'handyman' activities that resulted in falls from ladders, scaffolding and trees or being hit by falling objects. High falls were the mechanism of injury in over half of the 16 cases (n = 9) and resulted in injury to the thoracic spinal segments in 56% of the cases (n = 5).

Four per cent of the SCI cases (n = 11) occurred while people were involved in personal activities in their place of residence or at sports and recreation areas. Eighty-two per cent of these cases (n = 9) were the result of a low fall. Sixty-four per cent of these personal activity cases resulted in tetraplegia (n = 7). Older people were particularly at risk of SCI from low falls that occurred during activities such as rising from bed, when in bathrooms, or when rising from chairs or couches. Alcohol consumption or intoxication was reported in 27% of cases.

Other and unspecified activities accounted for the remaining 149 cases of SCI (Table 5.3). Nine of the SCIs occurred while people were being nursed or cared for and sustained injury to the cervical, thoracic and lumbar spine. Sixty-seven per cent of those being cared for were over the age of 75 years. The activity at time of injury was not reported in the injury narrative for the remaining cases and 66% (n = 108) of these cases were drivers, passengers or unprotected road users involved in motor vehicle accidents. Forty-two per cent of the 'Other/Unspecified' cases resulted in tetraplegia.

6 Glossary

ASIA: refers to the American Spinal Injury Association.

Duration of initial care: is the period of time from the date of injury to the date of discharge from the spinal unit (SU) to a patient's previous home, or to a new home, nursing home or other accommodation. This period of care includes retrieval of the patient from the scene of the accident, stabilisation in a hospital or intensive care unit, acute care in a SU and other wards, and rehabilitation.

Extent of SCI: refers to the extent of neurological damage, which is either 'complete' or 'incomplete'. If partial preservation of sensory and/or motor functions is found below the neurological level and includes the lowest sacral segment, the injury is defined as incomplete. The term 'complete injury' is used when there is an absence of sensory and motor function in the lowest sacral segment.

Incident case of SCI: a person who suffers an SCI, as defined by the CDC clinical definition, during a reporting period.

Neurological level of SCI: refers to the most caudal segment of the spinal cord with normal sensory and motor function on both sides of the body (i.e. the lowest level that has full function).

Paraplegia: refers to impairment or loss of motor and/or sensory function in the thoracic, lumbar or sacral (but not cervical) segments of the spinal cord, due to damage of neural elements within the spinal canal.

Tetraplegia: refers to impairment or loss of motor and/or sensory function in the cervical segments of the spinal cord due to damage of neural elements within the spinal canal. This term is etymologically more accurate than 'Quadriplegia', combining tetra + plegia, both from Greek, rather than quadri + plegia, a Latin/Greek amalgam. It is generally preferred outside the US.

Unprotected road users: refers to pedestrians, pedal cyclists and motorcycle riders.

Appendix

Structure and operation of ASCIR

The Australian Spinal Cord Injury Register (ASCIR) is a national register of incident cases of spinal cord injury which occur in Australia and overseas to Australian residents. The ASCIR operates as a collective venture of the Directors of all six spinal units (SUs) in Australia and the National Injury Surveillance Unit (NISU), a Collaborating Unit of the Australian Institute of Health and Welfare (AIHW). The ASCIR is funded as part of the NISU program, which is managed and operated by the Flinders University Research Centre for Injury Studies (RCIS).

ASCIR governance and management is under the auspices of the ASCIR Operation and Management Board. The current members of the Board consist of the Chair (a spinal unit Director), AIHW Data Custodian for ASCIR data, three spinal unit Directors, two spinal unit physicians/researchers, and two other members who have experience in the operation of registers.

This management structure optimises the operation and use of the ASCIR. It ensures maintenance and development occurs with input from ASCIR stakeholders, fosters collaboration between the RCIS/NISU and spinal unit Directors and research staff, and assists the person with the role of AIHW Data Custodian to fulfil the requirements of that role.

NISU, a Collaborating Unit of AIHW, is responsible for the security, proper operation and use of ASCIR data. The AIHW Data Custodian at NISU (Associate Professor James Harrison, Director) is responsible to the AIHW for ensuring that the operation of the Register and the use of Register data comply with AIHW policies and procedures. The Data Custodian also ensures that the analysis and dissemination of the data are in accord with purposes approved by the AIHW Ethics Committee, as well as security provisions required by Section 29 of the *Australian Institute of Health and Welfare Act 1987*.

Two groups of patients are admitted to spinal units: new incident cases and prevalent cases. From July 1, 1995 all new incident SCI cases were registered at the six SUs by registrars, ward clerks, or other attending health care workers.

The registration process begins in the spinal unit after patient stabilisation. The Director at each participating Unit is responsible for data collection and patient consent arrangements in their Unit. Consent arrangements differ between Units.

During the acute phase, the first page of the case registration form is completed, a copy sent to NISU and the original filed in the patient's case notes. Upon arrival at NISU, the data are checked for completeness and transcribed into the ASCIR database. In the case of electronic data reporting, the data are entered using a data uploading program in the Register's software. This process is the beginning of case registration of new incident SCI cases.

In terms of data reported, the scope of the first form includes patient history, demographic information, clinical assessment of patients during their acute stage of SCI, and a description of the event that led to their SCI.

At discharge of the patient from rehabilitation, the second part of the case registration form is completed. This form records details of their clinical status at discharge and any complications during the course of treatment and rehabilitation. A copy is forwarded to NISU to complete the registration process and the original is filed in the patient's case notes.

In order for the ASCIR to capture other non-registered prevalent cases, the registration status of each case is assessed as patients are admitted to the spinal unit. If patients are not identified as incident SCI cases and if they have not been registered previously, case registration forms are completed for each patient using incident SCI admission details from their case notes for the acute admission and rehabilitation phase of their episode of care. A readmission form is also completed for their current admission. In this way, the coverage of the Register is improved over time.

Data issues

Scope and ascertainment of SCI case registration data

All consenting patients identified as incident SCI cases admitted to all six SUs are reported to NISU for case registration. Complete enumeration of cases is confirmed by unit Directors or staff at the end of each reporting period (financial year 1 July through 30 June). Ascertainment of persisting traumatic SCI cases is high and these cases are the focus of the report. Almost all such cases that are admitted to a SU are included. The great majority of all cases of persisting traumatic SCI are thought to be included in the Register, with the partial exception of cases occurring at age extremes. Nearly all cases are added to the Register during the initial period of hospitalisation following injury. A small number of other cases are added when they attend a SU at a later time. We are not aware of reasons to think that ascertainment differs between SUs.

Paediatric cases (patients aged less than 15 years) are generally treated in paediatric hospitals and have generally not been included in the Register. Hence, the report focuses on the age range 15 years and older. Case registration of SCI from non-traumatic causes is known to be incomplete. These patients are often treated in other hospitals' specialised units (e.g. oncology) rather than at spinal units. Such cases are described briefly in this report.

A review of hospital separations from the Australian Institute of Health and Welfare National Hospital Morbidity Database estimated an average of 765 incident cases of SCI per year nearly half of which were admitted to a hospital with a spinal unit that contributes to the ASCIR (p 16, Henley, 2009). The review focused on spinal cord injury diagnoses over a six year period from 1st July 1999 to 30th June 2005 and included all ages and all hospitals. A major limitation to the review was the inability to link separation records referring to the same person. Data linkage would enable the identification of multiple admissions for the same person and allow tracking from the incident injury event to separation from rehabilitation. It would also enable reliable identification of re-admissions related to complications of spinal cord injury. Data linkage between the Australian Spinal Cord Register and the NSW Inpatient Statistics Collection provided invaluable information on rates, causes and morbidity in people with SCI over a 10-year time period in NSW (Middleton et al. 2004).

Rates

Incidence rates have been calculated as cases per million of the usually resident population of Australia. Population data were obtained from the Australian Institute of Health and Welfare and are similar to data presented in the Demographic statistics catalogue no. 3101.0 (ABS 2006a). Annual rates were calculated using finalised population estimates as at 31 December for each year.

Except where otherwise stated, all-ages rates have been adjusted to overcome the effects of differences in the proportions of people at different ages (and different injury risks) in the populations being compared. Direct standardisation was employed, taking the Australian population in 2001 as the standard.

Tabulations and data reported

Where cell counts are 3 or fewer, the value and related percentage are not shown in tables. The omission of these values is to prevent potential patient identification and breach of patient confidentiality. Cell values and related percentages greater than cell counts of 3 may also be omitted if row or column calculations would reveal omitted cell values less than 3.

Confidence intervals

The ASCIR is designed to register all new cases of SCI at ages 15 years and older, so sampling errors do not apply to these data. However, the time periods used to group the cases (i.e. financial years) are arbitrary. Use of another period (e.g. January to December) would result in different rates.

Where case numbers are small, the effect of chance variation on rates can be large. Confidence intervals (95%, based on a Poisson assumption about the number of cases in a time period) have been placed around rates as a guide to the size of this variation. Chance variation alone would be expected to lead to a rate outside the interval only once out of 20 occasions. An extreme rate in a single period of enumeration should not be ignored simply because of a wide confidence interval—a time series may show such a rate to be part of a trend.

Assignment and aggregation of NDS-IS codes

During case registration, incident cases of SCI from traumatic causes are routinely coded to NDS-IS Level 1 to meet the most basic requirement of injury surveillance. Injury data is coded to three data items: *External Cause – major groups and intent groups*, *Place of injury occurrence* and *Activity when injured*. In addition, a short narrative description of the circumstances of occurrence is collected.

To provide a smaller set of external cause categories that describe major mechanisms of injury that usually result in SCI, major groups of NDS-IS external causes (30 categories) were allocated to nine mechanism of injury categories. The structured injury narrative was used to cross check the existing external cause codes reported and to provide a consistent and accurate allocation process. Mechanism of injury and the NDS-IS main 'external cause' codes aggregated are summarised in Table A1.1.

Assignment to ASGC remoteness zones

The Australian Bureau of Statistics (ABS) has made available several concordance products to enable users to convert data for one type of geographic area (e.g. postcode) to another (e.g. Australian Standard Geographical Classification (ASGC) zones). Postcodes present in the ASCIR case records were recoded according to concordance tables sourced from the ABS into one of six available ASGC zones. For more information on the ASGC and conversion of data using concordance products please refer to the following ABS publication: Statistical geography volume 1 Australian Standard Geographical Classification (ASGC) 2006 (ABS 2006b).

Table A1.1: Mechanisms of injury and their relationship to NDS-IS external causes

Mechanism of injury	NDS-IS Level 1 code	Notes
Traffic—and transport: Motor vehicle occupants	1, 2	Includes only cases where *Place of injury occurrence* is 7 (Street or highway [public road]). Excludes cases where *Place of injury occurrence* is 8–12. *Activity when injured* for occupants of motor vehicles who are not involved in leisure activities are coded to 8 (Other specified activity)
Traffic—Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	3, 4, 5, 6	Includes cases where *Place of injury occurrence* is 7 (Street or highway [public road]) Excludes cases where *Place of injury occurrence* is 8–12
Non-traffic—Land transport: Motor vehicle occupants	1, 2	Includes cases where *Place of injury occurrence* is 8–12 Excludes cases where *Place of injury occurrence* is 7 (Street or highway [public road])
Non-traffic—Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	3, 4, 5, 6	Includes cases where *Place of injury occurrence* is 8–12 Excludes cases where *Place of injury occurrence* is 7 (Street or highway [public road])
Low falls (on the same level, or from a height of less than 1 metre)	9	
High falls (from a height of 1 metre or more)	8, 10	Includes falls from a horse
Struck by or collision with a person or object	24, 30, 31	Excludes cases (usually coded 31) that indicate from structured injury narrative water-related injuries
Water-related	31	Includes cases (usually coded 31) that indicate from structured injury narrative water-related injuries
Other	7, 19, 20, 25, 28, 29	Includes cases such as other transport, firearm, cutting, piercing object, electricity, other and unspecified external causes

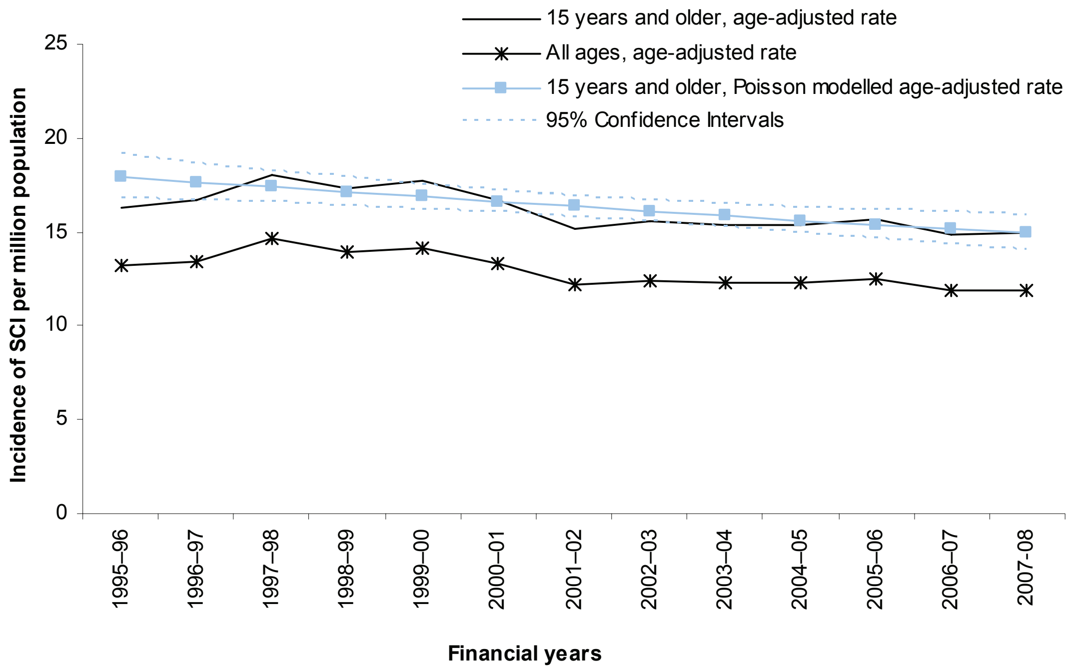


Figure A1.1: Incidence of persisting SCI from traumatic causes by financial year; Australia

In this report, trends in the incidence of persisting SCI from traumatic causes are presented in two ways. Both differ from the approach used in reports published before 2006. This section describes how the methods differ and compares the values obtained from each (Figure A1.1).

Figure 3.1 presents annual rates, age-adjusted by the direct method to the Australian population in 2001. Age-adjustment was used to allow for effects of change in the age composition of the Australian population. Analysis was restricted to ages 15 and older because that is the age-range for which ASCIR is considered to have good case ascertainment. These values are shown in Figure A1.1 as the series labelled '15 years and older, age-adjusted rate'. The values are as reported in previous editions of this document.

Figure A1.1 also presents results of Poisson modelling of age-adjusted rates. The modelled trend line shown is based on age-specific rates, which have been adjusted to take account of changing age composition. Analysis was restricted to the group aged 15 and older for the reason given above. Annual rates are shown in Figure A1.1 as the series '15 years and older, Poisson modelled age-adjusted rate'.

In reports published before 2006, we have generally reported all-ages rates of SCI, adjusted by the direct method. Rates calculated in this way are shown in Figure A1.1 as the series 'All-ages, age-adjusted rate'. This method does not allow for the likely under-ascertainment by the ASCIR of traumatic SCI cases occurring in those aged less than about 15 years. The values resulting from use of this method are about 20% lower than rates for those aged 15 years and older.

True rates of traumatic SCI in childhood are probably lower than rates in early adulthood. Hence, a version of the 'All-ages age-adjusted rate' series based on completely ascertained SCI at all ages would probably be higher than the series 'All-ages age-adjusted rate' as shown in Figure A1.1 and lower than the series '15 years and older, age-adjusted rate'.

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