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Spinal cord injury, Australia, 2005–06

Raymond A Cripps

Flinders University

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Spinal cord injury, Australia, 2005–06

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Clare Bradley is the co-author of Chapter 6.

Executive summary

The report *Spinal Cord Injury, Australia, 2005–06*, presents national statistics on spinal cord injury using data from the 2005–06 reporting period and updates the previous 2006 report.

The number and rate of new cases of persisting Spinal Cord Injury (SCI) due to traumatic causes in the Australian population have changed very little since the 2006 report. Overall, a total of 374 newly incident cases of SCI were reported in 2005–06. Two hundred and eighty-four cases were due to trauma and another 90 new cases of SCI were due to disease, not trauma. The age-adjusted rate of persisting SCI from traumatic causes was estimated to be 15.7 new cases per million population aged 15 years and older, slightly higher, but not significantly different from 2004–05 reporting period (15.4).

State and territory age-adjusted three-year annual average incident rates remained similar to rates in the 2006 report, with Western Australian rates significantly higher than the national incident rate and Victorian rates significantly lower.

The highest case count and age-specific rate occurred in the age group 15–24 years. Male rates of persisting SCI from traumatic causes were higher than female rates at all ages except among the age group 65 years and above.

Transport-related injuries (46%) and falls (33%) accounted for over three-quarters of the 284 cases of traumatic spinal cord injury (SCI) during 2005–06.

In the transport-related group, 37% of the SCI cases were caused by traffic accidents (106 cases) and 63 of these cases were vehicle occupants and 43 were unprotected road users, predominately motorcyclists (60%).

The number of motorcyclist cases in 2005–06 (26) was less in number than in the previous year (36) and were aged 15–44 years and 13% of all SCI cases in this age group.

Falls led to 95 cases of persisting spinal cord injury in 2005–06, higher than the number in the previous year (82). About two-thirds of these were falls from a height of 1 metre or higher (n=60), largely involving males aged 15–64 years, and commonly occurring during paid (n=16) or unpaid (n=16) work. Falls on the same level or from less than 1 metre led to spinal cord injury in 35 cases, 46% of these involving people aged 65 years or older.

Water-related accidents although accounting for only 9% of the SCI cases reported during 2005–06, 80% of the cases involved injury to the cervical spinal segments and tetraplegia. Most of these cases were under the age of 35 years.

Spinal cord injury is uncommon, but personal and health system costs per case are high. An indication of this is that the median duration of initial care following persisting spinal cord injury in 2005–06 was 211 days (almost 7 months), and 226 days for cases resulting in complete tetraplegia. Most cases of persisting spinal cord injury occur at young ages (25% of new cases registered in 2005–06 were at ages 15–24 years) and, provided initial injury is survived, life expectancy is generally long.

1 Introduction

Spinal cord injury (SCI) is sudden and unexpected, and it can be devastating and costly in human and social terms. Medical advances, especially in initial resuscitation and long-term care, have improved survival rates and increased longevity (Tyroch et al. 1997).

From the 1940s through to the 1960s, the level of acute care and rehabilitation of persons with SCI was poor, with few tetraplegic cases or high level paraplegics surviving (Stover 1995). Changes in acute care and rehabilitation, particularly in the development of a team approach to patient case management in the 1970s, brought about a significant reduction in premature mortality, especially from respiratory and renal diseases (Geisler et al. 1983); (Nakajima 1989); (DeVivo et al. 1993).

Each year in Australia, about 300–400* new cases of SCI from traumatic and non-traumatic causes are added to an estimated prevalent SCI population of about 9,000. Based on 2005 cost estimates (Walsh et al. 2005), the ongoing costs associated with the long-term care of the prevalent population of about 9,000 are estimated to be nearly A$500 million per year. These cost estimates allow for attendant care and equipment only and do not include medical or ancillary treatment. It should also be noted that this estimate of A$500 million may change quite markedly from year to year depending on the number of ventilator-dependent or high-level tetraplegia (C1–C3) cases that occur. Estimated attendant care and equipment costs for each ventilator-dependent and each non-ventilator dependent tetraplegic patient are about A$284,000 and A$197,000 per year, respectively (Walsh et al. 2005).

To facilitate national and international comparisons, the US Centers for Disease Control (CDC) case definition of SCI was adopted in Australia for registration of cases of SCI. The CDC's case definition of SCI is as follows:

> … 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:

(a) 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 2005 to 30 June 2006 (this period is abbreviated as '2005–06' in this report)

(b) clinical information on patients injured and admitted during 2005–06 who were Australian residents and acquired a persisting neurological deficit from injury to their spinal cord during 2005–06

(c) information on external causes of SCI to Australian residents and overseas visitors who were injured and admitted during 2005–06, and

(d) trends in work-related SCI in Australian residents during the period 1995–96 to 2005–06.

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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.

The following section (Section 2) of the report is an overview of case registration and reporting by spinal units, with a particular focus on the characteristics of the patients admitted during 2005–06. 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 of the injured Australian residents. Section 4 provides a clinical description of SCI cases of Australian residents injured and treated in 2005–06 who had a persisting neurological deficit 90 days after injury or at discharge from rehabilitation. Section 5 provides information on external causes of injury and factors associated with the SCI event for all traumatic cases (Australian residents and overseas visitors), and the last section presents an analysis of trends in SCI from work-related causes during the period 1995–96 to 2005–06.

This report is the 11th statistical report based on case registration data holdings of the Australian Spinal Cord Injury Register (ASCIR). 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 2003–04, 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 2004–05 period (Cripps 2006a). These reports can be downloaded from the AIHW web site located at: <www.AIHW.gov.au> or <www.nisu.flinders.edu.au>. Terms used in the report are defined in the Glossary (p.32).

The ASCIR, a cooperative arrangement of the six Australian spinal units and the AIHW National Injury Surveillance Unit in the Flinders University Research Centre for Injury Studies (RCIS), has enhanced its collaborative relationship with spinal units by the establishment of an ASCIR Operation and Management Board in late 2003.

In 2005–06, the ASCIR was in its 12th year of operation. Almost 11,500 cases of persisting SCI have been registered.

2 Overview of SCI case registrations in 2005–06

Six spinal units (SUs), located in five states and specialising in acute management and rehabilitation of SCI patients nationally, reported 374 newly incident cases of SCI during 2005–06. These spinal units each treat SCI patients Australia-wide.

Patients from states and territories which have no spinal units (Tasmania, the Northern Territory and the Australian Capital Territory) are normally sent to the nearest available spinal unit 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 newly 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. 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 2005–06, 284 of the 374 new SCI cases (76%) reported by the SUs incurred their SCI from traumatic causes (Table 2.1). Section 3 of the report deals with newly incident cases of persisting SCI from trauma in the Australian population (n=257) and excludes patients under the age of 15 years (0 cases).

Section 4 deals with the clinical characteristics of all the newly incident cases of persisting SCI from trauma in the Australian population (n=257). Section 5 deals with the external causes of all traumatic cases of SCI during 2005–06 which were notified to the ASCIR (n=284).

Twenty-four per cent of the cases of SCI registered in 2005–06 were from non-traumatic causes. In these cases, SCI was secondary to medical conditions such as ischaemia (10%), cancer (16%), spinal abscesses (6%) and spinal canal stenosis (6%). Other causes of SCI were related to disc disease, myelopathy, pain, and medical interventions. The average age of the patients in these non-traumatic cases was 59 years (S.D.=15), compared with 41 years (S.D.=19) for traumatic cases.

Other cases were those patients admitted with suspected SCI or transient cord concussion but who had no lasting neurological deficit (12 cases), patients who were reported to have died on ward, all 6 of which were due to trauma, and others who were non-residents of Australia who had their SCI in Australia (10 cases). This non-resident group is omitted from Australia incidence rate calculations, since the denominator is the population of usual residents of Australia. Australian residents who acquire SCI while elsewhere are within the scope of the register. Such cases are normally registered only if they are admitted to a spinal unit in Australia.

Table 2.1: Case registrations reported to ASCIR by spinal units; Australia 2005–06 (counts and column percentages)

Newly incident SCI case characteristics	Counts	Per cent
Traumatic causes:		
Australian residents		
Survived 90 days or to discharge, neurological deficit*	257	68.7
Survived 90 days or to discharge, no neurological deficit	11	2.9
Died on ward**	6	1.6
Non residents		
Survived to discharge, neurological deficit	10	2.7
Total traumatic causes* **	**284**	**75.9**
Non-traumatic causes:		
Australian residents		
Survived 90 days or to discharge, neurological deficit	89	23.8
Survived 90 days or to discharge, no neurological deficit	1	0.3
Died on ward**	0	0
Non resident		
Survived to discharge, neurological deficit	0	0
Total non-traumatic causes	**90**	**24.1**
Total newly incident SCI cases	**374**	**100**

* These cases are the focus of Sections 3 and 4. Includes 15 cases transferred from spinal units less than 90 days after injury and later verified by spinal unit to meet definition of *persisting SCI*.

** Of the 6 patients who died, all had an SCI from traumatic causes and 3 of these trauma cases were aged 65 years and above (mean age of 79 years).

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

3 Incidence of persisting SCI in 2005–06

This section of the report describes the incidence of persisting SCI from traumatic causes in Australian residents during 2005–06, and trends in rates for the period commencing 1995–96. The section also includes the incidence of SCI by state and territory of usual residence and socio-demographic characteristics of these persisting SCI cases.

Given the rarity at present of complete neurological recovery from SCI after 3 months, those patients discharged during financial year 2005–06 with a neurological deficit or having a deficit for at least 90 days after injury (257 cases) can be regarded as *persisting* cases of SCI. At the time of writing this report, 15 of the 257 cases had not been discharged from rehabilitation and remained on ward. All had persisting neurological deficits and are included in this section.

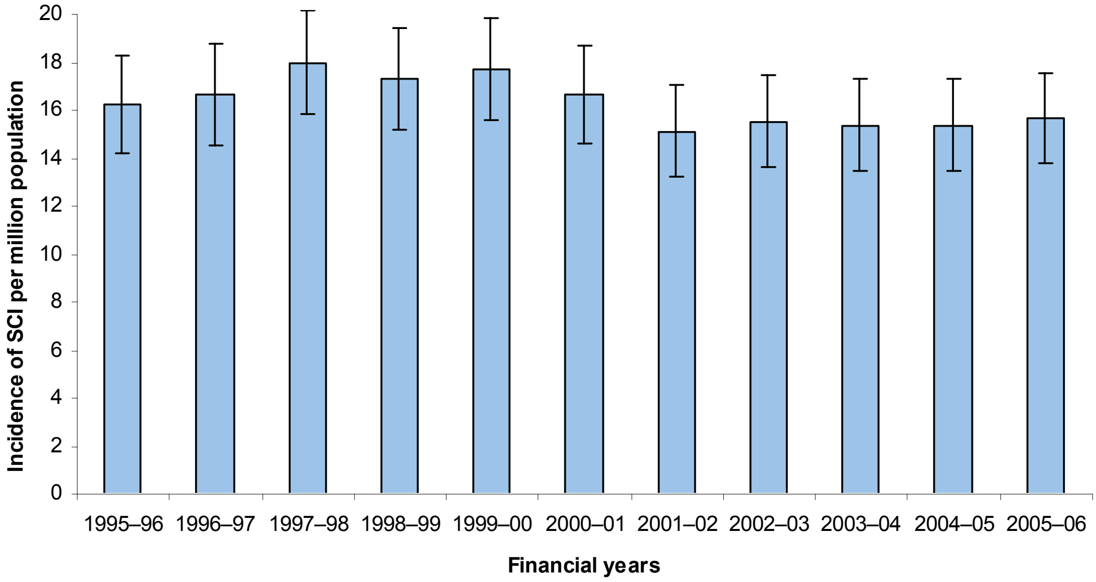
Clinical features of these cases are discussed in Section 4 of this report. These cases are an important group to monitor because they contribute to the prevalent SCI population whose health and welfare require ongoing care and (commonly) financial support. The size of the persisting SCI group reflects the combined effects of the rate of incidence of SCI, patients' response to retrieval and treatment, and the rate of survival to discharge. Two hundred and fifty-seven Australian residents who sustained SCI from traumatic causes during 2005–06 satisfy the case definition of persisting SCI.

3.1 Persisting SCI in 2005–06 and earlier years

The age-adjusted incidence rate of persisting SCI from traumatic causes in 2005–06 in the Australian population aged 15 years and older was estimated to be 15.7 new cases per million population aged 15 years and older (Figure 3.1). The rate was slightly higher than the rate in 2004–05 (15.4 new cases per million population), but not significantly different (95% CI=13.8–17.6). The values shown are rates for persons aged 15 years and older, standardised by the direct method to the Australian population in 2001.

No cases of patients aged under 15 years were registered in 2005–06. 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 hospitals rather than SUs.

Further analysis of trends in persisting SCI is presented in Chapter 6 and in the appendix.



Note: Error bars indicate 95% confidence intervals for rates. Direct age standardisation was employed, taking the Australian population in 2001 as the standard.
Rates are based on persisting cases of SCI for Australian residents who had their SCI in Australia (257 cases in 2005–06). Rates for earlier years are as reported in previous issues of this report.

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

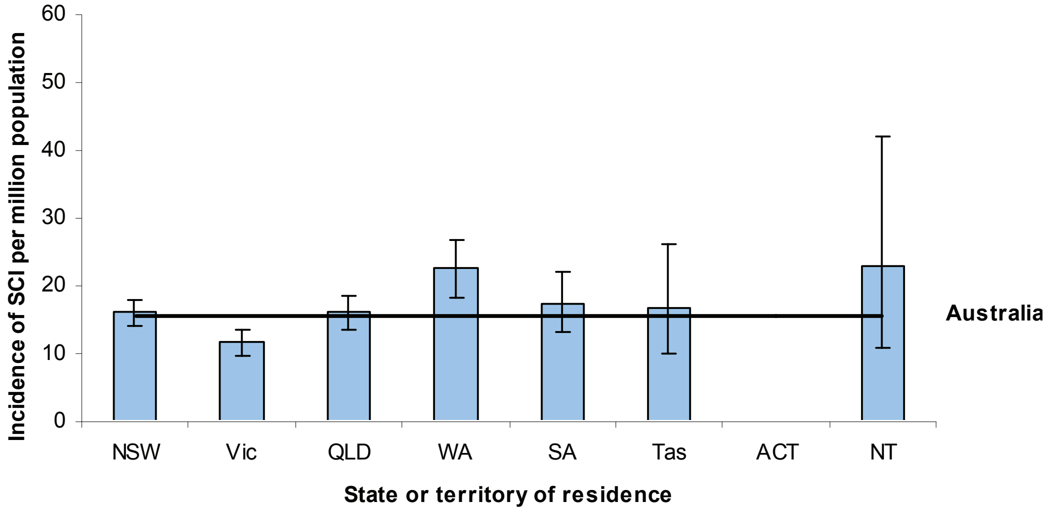
The age-adjusted rate of incidence of persisting SCI from traumatic causes by state and territory of usual residence is presented in Figure 3.2. Because of the small number of cases in some jurisdictions, incidence rates for jurisdictions are annual average rates based on cases in the three years 2003–04 to 2005–06. (This differs from calculations in reports before 2003–04.)

Three-year case counts for Tasmania (19 cases) and the Northern Territory (10 cases) were low, which is reflected in the wide confidence intervals for these two jurisdictions. No cases were reported from the Australian Capital Territory.

The incidence rates range from a high of 22.9 persisting SCI cases per million of population in Northern Territory to a low of 11.7 SCI cases per million of population in Victoria.

Residents of Western Australia had a three-year annual average incident rate of persisting SCI that was significantly higher than the national incident rate (22.5 cases per million population versus 15.5 cases per million population). Only residents of Victoria had three-year annual average incident rates of persisting SCI significantly lower than the national incident rate (11.7 cases per million population versus 15.4 cases per million population).

While the rate for NT did not differ significantly from the national rate, it is noteworthy that the point estimate for the period shown here is high, as it has been in previous periods.



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 3.2: Incidence of persisting SCI from traumatic causes by state or territory of usual residence; Australia 2002–03 to 2005–06 (three-year annual average rates, age 15 years and over)

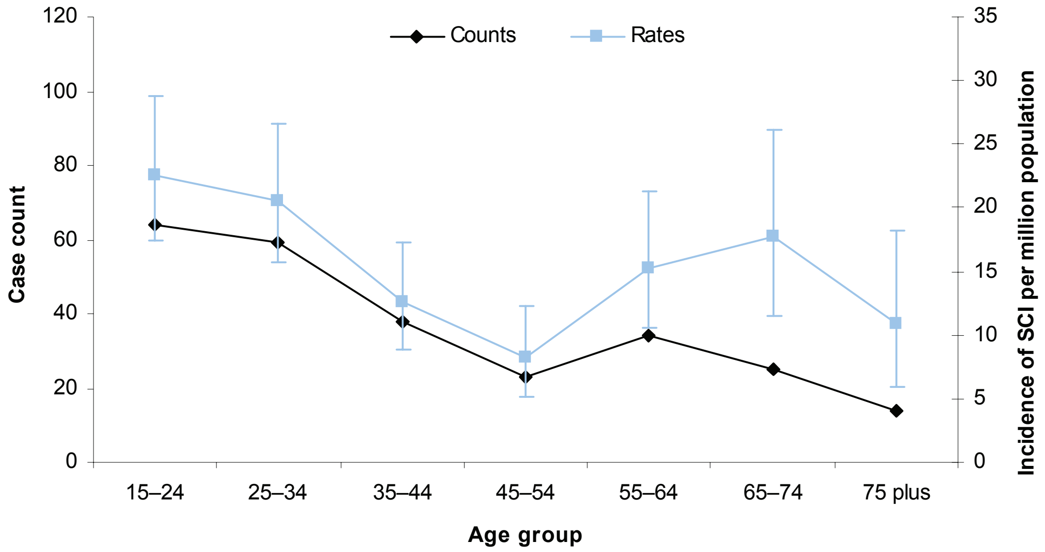
3.3 Age and sex distribution

The age distribution of cases and rates of persisting SCI from traumatic causes is presented in Figure 3.3. The highest case count and age-specific rate occurred in the age group 15–24 years (Figure 3.3). The 15–24 year age group accounted for 25% (n=64) of the cases of persisting SCI from traumatic causes. Point estimates of age-specific rate declined with increasing age until age group 45–54 years, then increased to age group 65–74 years and declined thereafter.

The 95% confidence intervals on the rates, based on the Poisson distribution, indicated that in 2005–06, age-specific rates for age groups 15–24 and 25–34 years were significantly higher than rates in the 45–54 year age group. The pattern of age-specific rates were more variable than those reported in 2004–05, but the pattern was more similar to those reported in 2003–04.

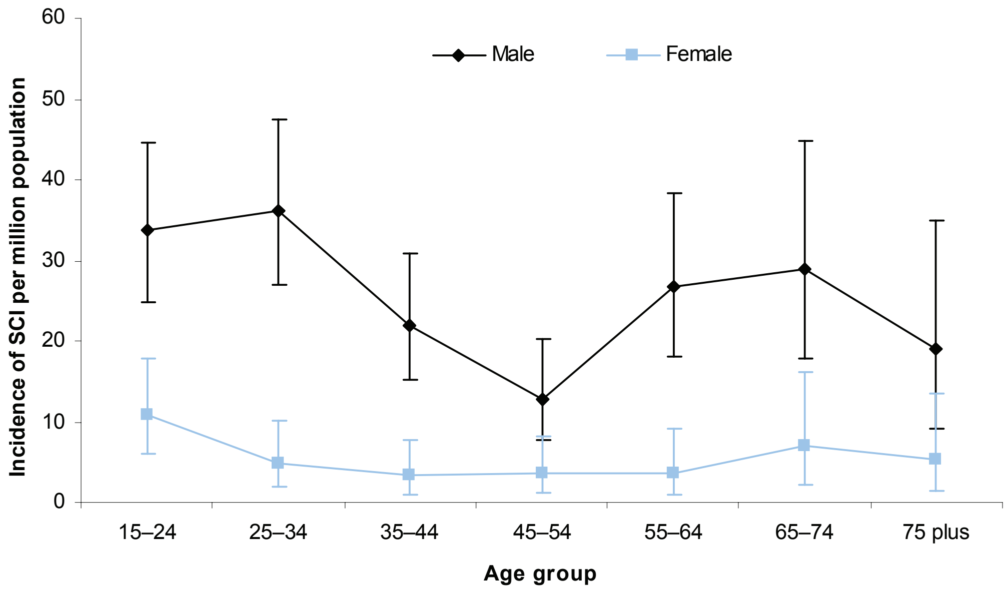
Of the cases of persisting SCI from traumatic causes, 82% were male and 18% were female. All-ages male and female rates were respectively 26.1 and 5.4 persisting SCI cases per million population, with a M:F ratio of 4.8.

Rates for males were higher than rates for females at all ages though 95% confidence intervals overlap for age groups 45–54 and 75 years and above (Figure 3.4). The difference was greatest for young adults and least in middle age. The male to female rate ratio ranged from a low of 3.1:1 in the age group 15–24 years, to a high of 7.4:1 in the age group 55–64 years. Case counts for people aged 75 years and above were low, and accounted for about 5% of the new cases of persisting SCI from traumatic causes. A frequency count of persisting SCI cases during the operation of the ASCIR by age at onset, indicates the highest number of persisting SCI cases occurred at age 21 years, followed by a decline in number of cases with increasing age.



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

Figure 3.3: Incidence of persisting SCI from traumatic causes by age group, Australia 2005–06 (counts and age-specific rates)



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

Figure 3.4: Incidence of persisting SCI from traumatic causes by age group and sex, Australia 2005–06 (age-specific rates)

3.4 Socioeconomic characteristics

Living successfully with SCI after rehabilitation is dependent on a number of factors. Psycho-social factors such as internal locus of control, family support, education, employment, and developed social skills all contribute to personal role performance and environmental integration in spite of disablement (Stiens et al. 1997); (Warren et al. 1996); (Athanasou et al. 1996).

Marital status, employment status and educational level attained (education status) at the time of onset of persisting SCI are three socioeconomic factors recorded in the ASCIR which may affect the outcome after rehabilitation and are presented as age-specific populations in Tables 3.1–3.3.

Forty per cent of the patients were married or in a de-facto relationship, proportionally similar to the marital status reported in 2004–05 for this group, but less than the proportion reported (45%) for the Australian population in 2005 (ABS 2005) (Table 3.1). Over one-half (53%) of the 'never married' group were young adults aged 15–24 years. In terms of post-rehabilitation care, a patient's spouse may be the main provider of care, which over the long term may affect the health and well-being of the spouse or the relationship (Weitzenkamp et al. 1997). For unmarried patients, care may be provided by the patient's parents or other relatives. For the 15% of patients who were widowed, divorced or separated, care may be provided also by family or friends (depending on age or level of care needed) or in health care facilities and nursing homes.

Sixty-five per cent of those who acquired persisting SCI were employed when their SCI occurred (Table 3.2), similar to the employed crude proportion (62%) of Australians aged 15 years and older (ABS 2007). In addition, age-specific proportions of SCI cases who were employed at time of injury were similar to employed proportions of Australians at ages 15–24 years (64% versus 66%) and at ages 25–64 years (78% versus 74%). At ages 65 years and above, the employed proportion of people acquiring SCI was higher than the employed proportion for the entire population of Australians at ages 65 and older (16% versus 8%).

Sixty-one per cent of the people who acquired persisting SCI were working in service industries compared to 75% of the total employed Australian population in 2005. In highest skilled occupations (ASCO Skill Level 1), there were a slightly higher proportion of managers, administrators and professionals in the SCI group than in the Australian working population (34% versus 27%). There were also proportionally more low skilled occupations (ASCO Skill Level 5, elementary clerical, sales and service workers and labourers and related workers) employed in the SCI group (33% versus 19%) (ABS 2005). These comparisons are based on proportions of employed persons aged 15 years and above and are not age-adjusted.

Overall, 13% had a tertiary or post-graduate education and the same proportion attained the highest available secondary school level (Table 3.3).

The vocational potential of people with persisting SCI in Australia is quite good, with about 40% of people with SCI returning to work (Athanasou et al. 1996). Returning to paid work is not only determined by physical abilities and rehabilitation, but also by economic circumstances and the willingness of employers to hire workers with disabilities (Post et al. 1998).

Table 3.1: Marital status at onset of persisting SCI by age group: patients reported to ASCIR by spinal units; Australia 2005–06 (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	58	91	50	32	**	**	**	**
Widowed	**	**	5	3	10	26	15	6
Divorced	**	**	8	5	**	**	10	4
Separated	**	**	10	6	**	**	13	5
Married (includes de facto)	6	9	76	49	21	54	103	40
Not stated	**	**	5	3	**	**	**	**
Group total	**64**	**100**	**154**	**100**	**39**	***100***	**257**	***100***

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

Table 3.2: Employment status at onset of persisting SCI by age group: patients reported to ASCIR by spinal units; Australia 2005–06 (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	41	64	117	78	6	16	164	65
Pensioner	0	0	9	6	30	79	39	15
Unemployed/Not available for employment-school/other	23	36	24	16	**	**	49	19
Group total	**64**	**100**	**150**	**100**	**	**100**	**252**	**100**

* Employment status for 5 cases was not reported.

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

Table 3.3: Educational level attained at onset of persisting SCI by age group: patients reported to ASCIR by spinal units; Australia 2005–06 (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	7	11	19	13	5	14	31	13
Trade qualification/apprentice	14	23	31	22	**	**	**	**
Diploma or certificate	4	7	9	6	4	11	17	7
Highest available secondary school level	11	18	16	11	5	14	32	13
Left school aged 16 or over	4	7	22	15	**	**	**	**
Left school aged 15 or less	5	8	28	19	7	19	40	17
Still at school	12	20	**	**	**	**	13	5
Not available/not reported	4	7	**	**	**	**	33	14
Group Total	**61**	**100**	**144**	**100**	**36**	**100**	**241**	**100**

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

Education status for 16 cases was not reported.

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, and 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.

In this report, 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 2005–06 from traumatic causes, had an ASIA score of A to D either 90 days post injury or at discharge from rehabilitation (end of episode of inpatient care), and incurred the injury in Australia or overseas. During 2005–06, 242 SCI cases admitted to SUs met this definition. Of these 242 cases, 15 cases were still on ward at the time of writing this report and 16 cases were discharged from the spinal unit where the incident admission occurred to another hospital. All 31 cases had been on ward or discharged from the spinal units at least 90 days after their injury date and are by definition *persisting* SCI cases.

An additional 15 cases with neurological deficits were transferred from spinal units to other hospitals less than 90 days after their injury date. For these cases, their neurological status is known (all had neurological deficits) when they transferred from spinal units to other hospitals. Spinal unit Directors and their staff were contacted to determine whether or not these cases would remain persisting cases at the end of their episode of inpatient care. The consensus was that all were likely to have some neurological deficit at the end of their episode of inpatient care and could be regarded as persisting SCI cases. These 15 cases, combined with the other 242 persisting SCI cases, comprise the 257 cases analysed in this section.

The 257 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 211 cases among the 257 who are known to have been discharged from a spinal unit to their original home or other residential care will be used in estimating the duration of initial care (DIC) values presented in the last part of this section.

4.1 Neurological level of injury

The neurological level of persisting SCI at discharge is presented in Figure 4.1.

More than half of the cases involved the cervical segments (52.5%, n=135). Injury to the cord at the cervical level results in reduction or loss of motor and/or sensory function in the arms as well as in the trunk, legs, and pelvic organs. This type of impairment is referred to as *tetraplegia*.

Fifty-four cases were reported as being at the C4 neurological level. This means that the motor and sensory functions served by the C4 segment of the spinal cord were the lowest (i.e. furthest from the head) that were found to be normal. Another 31 cases were at the C5 neurological level and 21 at the C6 level. Together, C4, C5 and C6 cases made up 79% of cases of persisting cervical SCI that occurred in 2005–06 and 41% of cases at all neurological levels.

The remaining 122 cases (47.5%) had an injury at the thoracic or lumbar levels, most commonly involving the spinal segments at the thoraco-lumbar junction (T12 and L1, n=31, 12% of cases at all levels). The impairment resulting from injury at these levels is referred to as *paraplegia*. With paraplegia, upper limb function is spared but, depending on the level of injury, the trunk, pelvic organs and lower limbs may be functionally impaired. No injuries at sacral levels were reported in 2005–06.

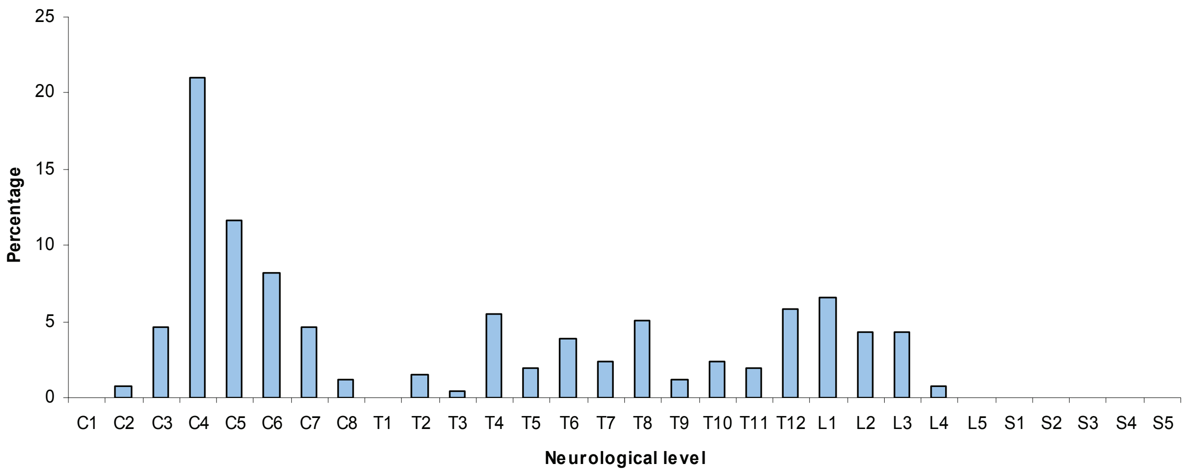


Figure 4.1: Incidence of persisting SCI from traumatic causes by neurological level at discharge; Australia 2005–06 (percentages)

4.2 Neurological category

The overall severity of SCI is usually measured by a combination of the neurological level and extent of injury and is divided into 5 neurological categories (complete tetraplegia, incomplete tetraplegia, complete paraplegia, incomplete paraplegia, and complete recovery). Table 4.1 presents the counts and table percentages for the 4 neurological categories relevant to a discussion of persisting cases of SCI, as well as a finer breakdown of the paraplegia category.

Based on all cases reported (257 cases), the most common neurological category was incomplete tetraplegia (37%, n=94), followed by incomplete paraplegia (28%, n=73), complete paraplegia (19%, n=49) and complete tetraplegia (16%, n=41). Complete injury was most common in the thoracic spinal segments, due to the small diameter of the spinal canal in this region in relation to the size of the cord (White & Panjabi 1990). In 2004–05, the number of patients that suffered injury to the thoracic and lumbar spinal segments was quite different from the number reported in 2005–06. Patients with thoracic spinal injuries decreased from 93 cases in 2004–05 to 82 cases in 2005–06 and lumbar spinal injuries increased from 25 cases to 40 over the same period. This could be explained in part by the difference in reporting of neurological levels associated with the T12/L1 spinal segments and T10, L2 and L3. No sacral spinal segment injuries were reported in 2005–06, compared with 3 cases in 2004–05.

Table 4.1: Incidence of persisting SCI from traumatic causes by neurological level (major grouping) and extent of injury; Australia 2005–06 (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	41	30	45	55	4	10	0	0	49	40	90	35
Incomplete	94	70	37	45	36	90	0	0	73	60	167	65
Total	**135**	**100**	**82**	**100**	**40**	**100**	**0**	**0**	**122**	**100**	**257**	**100**

4.3 Duration of initial care

When this report was prepared (January 2007), 211 of the 257 cases of persisting SCI incident in 2005–06 had been discharged from SUs after completing rehabilitation. For this report, *duration of initial care* (DIC) is the period of time from the date of injury to the date of discharge from the SU to their 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 an SU and other wards, and rehabilitation. 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. In this tabulation, the average duration of initial care (ADIC) has been replaced by the *median* duration of initial care (MDIC) to reduce the effect of outliers. In the discussion, ADIC values are provided to assist in comparing tabulations from previous reports. The duration of initial care for cases incident in 2005–06 also does not include all cases (31 cases transferred to other hospitals and 15 cases not discharged from spinal units) which may have an effect on the MDIC of persisting SCI cases incident in 2005–06.

The 31 cases transferred from spinal units to other hospitals had the following ASIA impairment scores when discharged from spinal units: *ASIA A* (12 cases); *ASIA B* (4 cases); *ASIA C* (4 cases) and *ASIA D* (11 cases). Sixty-five percent (n=20) of the 31 cases had injury to the cervical spinal segments, 12 had complete lesion of the cord and 6 had central cord syndrome.

The median duration of initial care (MDIC) for all cases of SCI incident in 2005–06 and discharged by January 2007 (211 cases†) was 130 days (ADIC 140 days), ranging from a high of 226 days (ADIC 228 days) for cases of complete tetraplegia to 92 days (ADIC 100 days) for cases of incomplete paraplegia involving injury to lumbar spinal segments.

† Of the non-discharged cases, 15 cases were still on ward in January 2007 and 31 cases had been discharged from initial acute care to another acute care hospital and post-rehabilitation discharge details were not known.

Table 4.2: Neurological status of injury to the spinal cord of cases of persisting SCI from traumatic causes for age groups discharged during 2005–06 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	25	226	41	140	3	129	0	0	44	140	69	170
Incomplete	77	126	31	125	34	92	0	0	65	111	142	116
Total	**102**	**152**	**72**	**135**	**37**	**99**	**0**	**0**	**109**	**124**	**211**	**130**

Overall, patients with tetraplegia had a MDIC 23% greater than those with paraplegia (152 days versus 124 days) For patients with paraplegia, the longest MDIC was reported for those with complete injury to the thoracic spinal segments. The MDIC for those with complete injury to the lumbar spinal segments was also high, but cases were fewer in number than cases with complete injury at the thoracic level (41 cases versus 3 cases).

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 distribution of durations is illustrated in Table 4.3 and Figure 4.2.

For tetraplegic patients, the 5th and 95th percentiles of length of stay were 22 and 302 days compared to 32 and 208 days for paraplegic cases (Table 4.3). The longest MDIC occurred while treating patients with complete tetraplegia (226 days); however, the 5th and 95th percentiles for duration of initial inpatient treatment for this group were 72 days and 302 days, illustrating the effect of patient case mix, small numbers at spinal units, as well as other factors mentioned above, on MDIC. 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 2005–06 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	25	226	72	302	44	140	84	234
Incomplete	77	126	16	317	65	111	26	205
Group Total	**102**	**152**	**22**	**302**	**109**	**124**	**32**	**208**

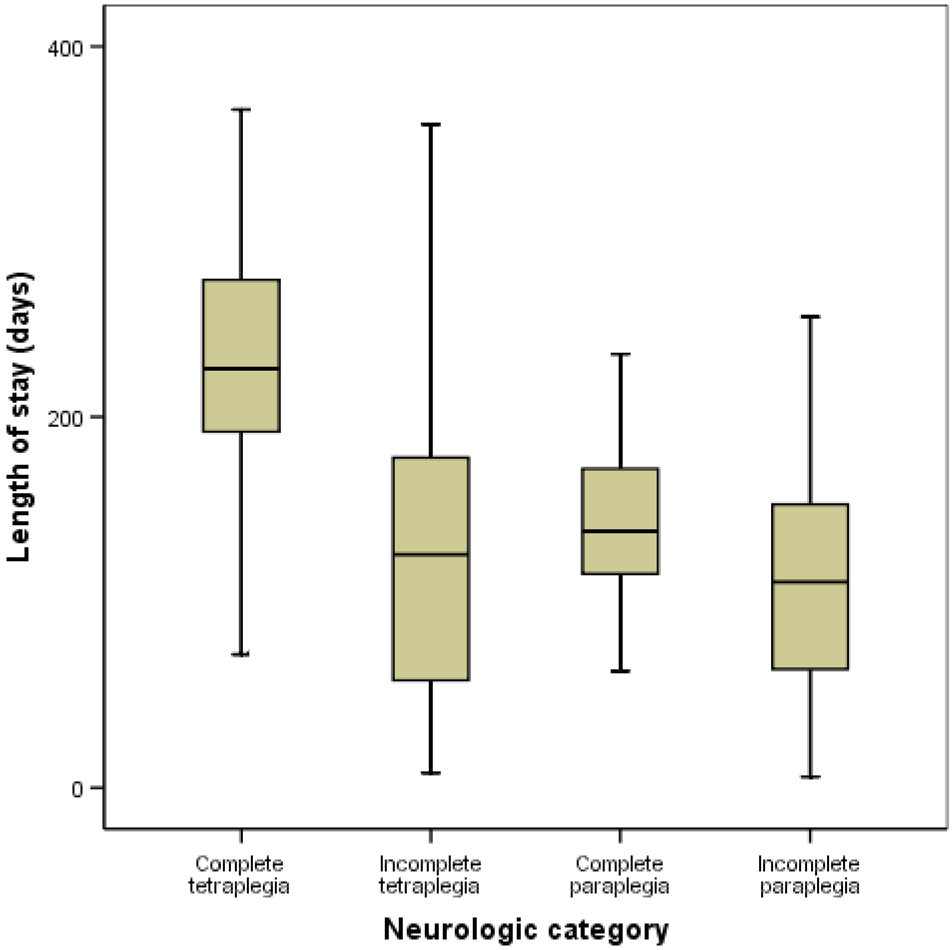


Figure 4.2: Distribution of length of stay by neurological category at discharge, Australia 2005–06 (median and percentiles [5th, 25th, 75th and 95th])

All neurological categories with extent of injury *complete* show a positive skew in the distribution of values of duration of initial care, with the median having a lower value than the mean. The neurological categories *incomplete tetraplegia and complete paraplegia* have one value each greater than the 95th percentile and the neurological category *complete tetraplegia* has one value less than the 5th percentile.

An examination of cases which had prolonged length of stay (positive skew), indicated that traumatic brain injury and spinal cord injury were present which could account for the extended length of stay for these patients.

5 Factors associated with the SCI event

In addition to collecting information on the incidence of SCI, including socio-demographic features of the patients involved, the ASCIR also collects information about the event which resulted in the injury, such as the mechanism of the injury, the role of human intent, the type of place where the injury occurred, and the type of activity involved at the time of injury. Such factors are often referred to as *External Causes of Injury*. This information, obtained from case registration forms of all incident SCI cases from traumatic causes (n=284) 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. Although eleven of these cases resulted in no persisting neurological loss, the aetiology was related to transport, falls and work-related accidents—common causes of SCI. 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.

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 Appendix 1, Data issues, Table A1.1.

5.1 Mechanism of injury

The mechanisms of injury for incident cases of SCI from traumatic causes are shown in Table 5.1. These cases, originally coded to NDS-IS, have been allocated to categories which reflect major mechanisms of injury that resulted in SCI. Mechanism of injury by age group is presented in Figures 5.1–5.3. Cases are described by mechanism of injury and neurological level of injury in Table 5.2. The mechanisms of injury shown in Table 5.1 are described in the following sections.

Table 5.1: Incidence of SCI from traumatic causes by mechanism of injury; Australia 2005–06 (counts and column percentages)

Mechanism	Counts	Per cent
Traffic–Land transport: Motor vehicle occupants	63	22
Traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	43	15
Non-traffic–Land transport: Motor vehicle occupants	6	2
Non-traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	20	7
Low falls (on the same level, or from a height of less than 1 metre)	35	12
High falls (from a height of 1 metre or more)	60	21
Struck by or collision with a person or object	22	8
Water-related	25	9
Other	10	4
All mechanisms	**284**	**100**

5.1.1 Traffic–Land transport: Motor vehicle occupants

The age distribution of SCI cases did not differ greatly between the land transport groups, nor between these groups and all traumatic SCI (Figure 5.1).

Additional information relevant to reducing SCI for motor vehicle occupants was obtained from the structured injury narrative. The most common type of event resulting in motor vehicle occupant SCI was vehicle rollover, accounting for 51% (n=32) of the cases. (Higher case numbers were reported in 2005–06, 8% more than the equivalent proportion [43%, n=29] reported in 2004–05.) High speed and loss of control appear to be major contributing factors in more than two-thirds of the accidents involving rollover. Ejection of occupant occurred in 6% (n=2) of the rollover cases resulting from lack of use or failure of seat belts, fewer cases than reported in 2004–05 (35%, n=11). Impact with a roadside hazard occurred before rollover in 16% (n=5) and a driver being intoxicated was also reported in 13% (n=4) of the rollover cases.

For non-rollover motor vehicle occupant cases (n=31), impact with another vehicle was reported in 29% (n=9) of the accidents, 45% (n=14) involved an impact with roadside hazards such as poles, trees or ditches, and ejection of occupants occurred in 6% (n=2) of the cases.

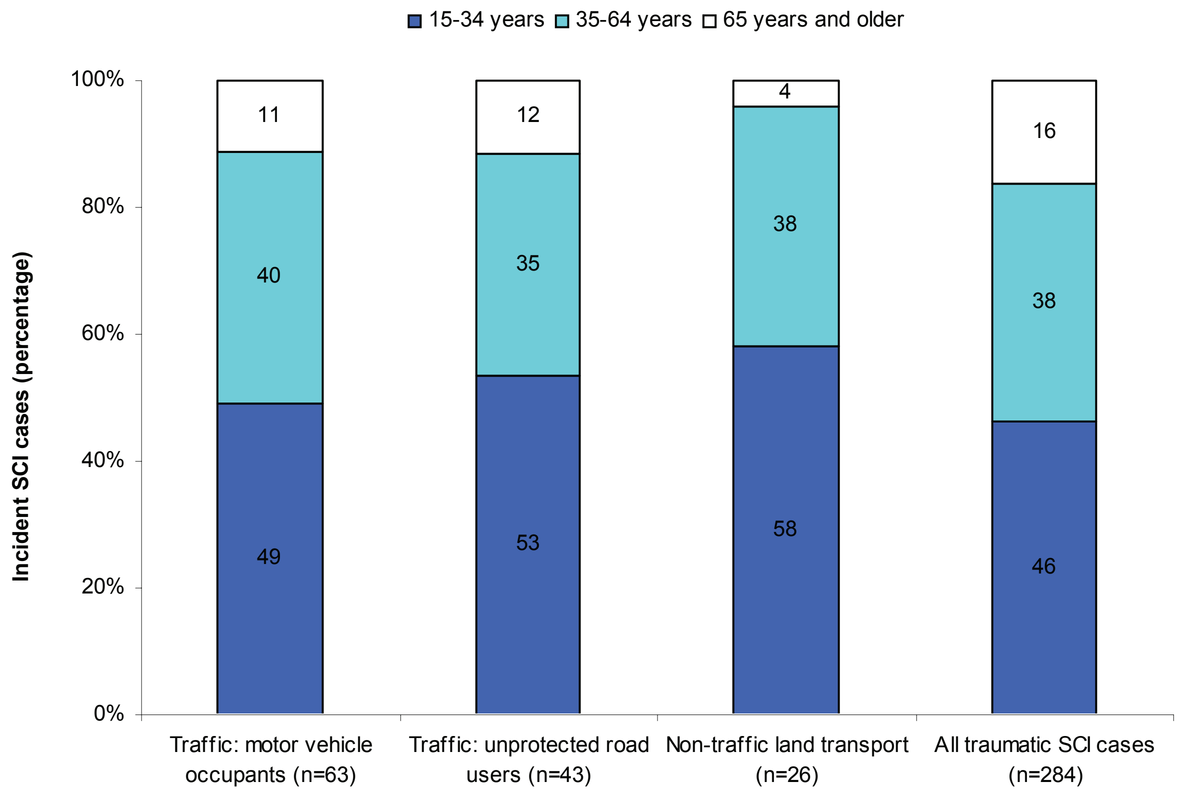


Figure 5.1: Incidence of SCI from traffic and non-traffic land transport accidents by age group, Australia 2005–06 (percentages of each group)

In motor vehicle accidents, high energy transfer to occupants is common and can result in high severity injury to many body regions, including the spinal column. For example, 62% (n=39) of the cases in the *Traffic–Land transport: Motor vehicle occupants* group sustained injuries to the cervical spinal segments resulting in tetraplegia (Table 5.2) and over half of the tetraplegic cases (n=20) were the result of vehicle rollover. Head injuries, including loss of consciousness, were also reported in 25% (n=16) of motor vehicle accident cases. Additional injuries sustained in motor vehicle accidents included internal damage, particularly to the thoracic cavity (e.g. pneumo and haemo-thoraces, fractured ribs and sternal bones), injuries to the abdomen, and various fractures to upper and lower limbs.

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, 2005–06 (counts and row percentages)

	Tetraplegia		Paraplegia											
	Cervical		Thoracic		Lumbar		Sacral		All paraplegia		No neurological loss		Total	
Mechanism	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	39	62	14	22	9	14	**	**	23	37	**	**	63	100
Traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	12	28	24	56	6	14	**	**	31	72	**	**	43	100
Non-traffic–Land transport: Motor vehicle occupants	**	**	**	**	**	**	**	**	**	**	**	**	6	100
Non-traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	7	35	8	40	**	**	**	**	11	55	**	**	20	100
Low falls (on the same level, or from a height of < 1 metre)	27	77	4	11	**	**	**	**	6	17	**	**	35	100
High falls (from a height of 1 metre or more)	24	40	20	33	14	23	**	**	34	57	**	**	60	100
Struck by or collision with a person or object	12	55	5	23	**	**	**	**	8	36	**	**	22	100
Water-related	19	76	4	16	**	**	**	**	5	20	**	**	25	100
Other	**	**	**	**	**	**	**	**	**	**	**	**	10	100
All mechanisms	**147**	**52**	**84**	**30**	**42**	**15**	**0**	**0**	**126**	**44**	**11**	**4**	**284**	**100**

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

In cases involving rollover (n=32), 63% (n=20) of the occupants had injury to the cervical segments of the cord resulting in tetraplegia. Thirty per cent (n=6) of these cases resulted in complete tetraplegia. The remaining rollover cases (n=12) had injury to the thoracic and lumbar spinal segments resulting in paraplegia and a half of these cases had complete injury to the cord resulting in complete paraplegia.

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 15% (n=43) of all cases of SCI during 2005–06 (Table 5.1).

Fifty-three per cent (n=23) of these unprotected road user cases in 2005–06 were in the age group 15–34 years compared with 46% (n=131) of all traumatic SCI cases. Only 12% (n=5) of unprotected road user cases were at ages 65 years or older (Figure 5.1). For these traffic-related cases, 60% (n=26) were motorcyclists, 16% (n=7) pedal cyclists and 23% (n=10) pedestrians. Motorcyclists in the 15–44 year age group (n=22) represented 85% of motorcycle cases at all ages and 13% of all SCI cases in this age group. For pedal cycle and pedestrian cases, nearly two-thirds of the cases were in the age group 15–54 years.

The neurological level of injury in unprotected road users in traffic was cervical in 28% of the cases (n=12), and thoracic and lumbar (no sacral cases) in the remainder, resulting in a higher proportion of paraplegia cases (72%, n=31) than tetraplegia cases (Table 5.2).

Forty-four per cent (n=19) of 2005–06 cases of SCI among unprotected road users in traffic had complete lesion of the spinal cord. Thirteen of these 19 cases (68%) involved motorcyclists or their passengers.

5.1.3 Non-traffic–Land transport

Non-traffic related accidents occurred primarily off-road on farms, trail or mountain bike tracks, race tracks, beaches and other undeveloped recreational areas. Fifty-eight per cent (n=15) of these cases were in the age group 15–34 years (Figure 5.1).

When compared with all traumatic SCI cases, the number of non-traffic motor vehicle occupants and unprotected road user cases was proportionally higher in young ages (ages 15–34 years) and similar at ages 35–64 years (Figure 5.1). Non-traffic motor vehicle occupant case numbers were low (n=6).

Twenty-three percent (n=6) of the non-traffic group were motor vehicle occupants and 77% were unprotected road users. Sixty per cent (n=12) of these unprotected road users were motorcyclists (drivers, no pillion passengers), 15% (n=3) were pedal cyclists and the remainder (n=5) were pedestrians or drivers of a motorised transport device (quad bike). When compared with non-traffic unprotected road user cases reported in 2004–05, motorcyclists increased proportionally by one third in 2005–06 and pedal cyclists were proportionally lower (15% versus 24%).

The age profile for non-traffic motorcyclists was slightly higher than that of traffic motorcyclists, with 85% (n=22) of the cases occurring in the 15–44 year age group. Non-traffic pedal cyclists were more than twice the number of traffic pedal cyclists and were generally riders over the age of 44 years.

For the non-traffic group, the number of tetraplegia cases was, proportionally, slightly higher than the number of cases in the traffic group (30% vs 26%), with injury to cervical spinal segments less than injury to the thoracic spinal segments.

Forty-two per cent (n=11) of 2005–06 cases of SCI among the non-traffic group had complete lesion of the spinal cord, with 33% (n=5) of the cases with complete lesion of the cord occurring in motorcyclists as complete paraplegia.

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 33% (n=95) of SCI cases during the 2005–06 reporting period (Table 5.1).

Although low falls were less frequent than high falls in 2005–06 overall (35 cases versus 60 cases), they were proportionally more than twice as common as high falls at ages greater than 65 years (Figure 5.2). Seventy-seven per cent of low falls (n=27) occurred in the patient's home while they were doing personal activities, as a result of medical conditions (seizures, cerebro-vascular accident or cardiovascular disease) or while using a walker. Alcohol intoxication was reported in 6 low fall cases.

Slipping or tripping occurred in about one-quarter of low fall cases in people aged 65 and older. Older people are at risk of fall-related injuries particularly fractures of the upper and lower limbs and the neck and trunk (Cripps & Carman 2001).

Low falls resulted in tetraplegia in 77% of cases (n=27) as a result of injury to the cervical spinal segments (Table 5.2). Paraplegia was less common (n=6) and involved injury to thoracic and lumbar spinal segments. Among those aged 65 years and older, tetraplegia occurred in 81% (n=13) with extent of injury to the cervical segments of the cord being incomplete in all but two of the cases.

Sixty-three per cent (n=60) of the injurious falls were from a height of 1 metre or more. Seventy-five per cent of those whose injury resulted from falling from a height were aged between 15–64 years, compared with 51% of those involved in low falls (Figure 5.2).

Twenty-eight per cent (n=18) of high falls occurred while the patients were working for income using ladders or scaffolding on building sites, while using or repairing mechanical devices such as 'cherry pickers', farm machinery or lifts, and during loading or unloading work-related activities.

Twenty-five per cent of high falls (n=15) involved activity which can be described as work, but not for income, such as doing handyman jobs around the home (using a ladder, on a roof, or cutting tree branches). Sixty-seven per cent of the people who fell during 'handyman' types of activities (n=10) were aged 54 years and above.

Eight per cent of cases involving high falls (n=5) were by people who were intoxicated, with 4 of the cases occurring in the 15–34 year age group. Leisure and sporting activities such as horse riding, paragliding and rock climbing accounted for 20% (n=12) of the cases.

Falling from a height resulted in tetraplegia in 40% of the cases (n=24) and paraplegia in 57% (n=34) of the cases (see Table 5.2). This differs from the results reported in 2004–05 where proportionally more high falls resulted in tetraplegia (53%, n=28). In the 2005–06 paraplegic cases, injury to the thoracic spinal segments was more common than injury to lower spinal segments. Fifty-eight per cent (n=35) of the cases resulting from high falls had an incomplete lesion of the cord.

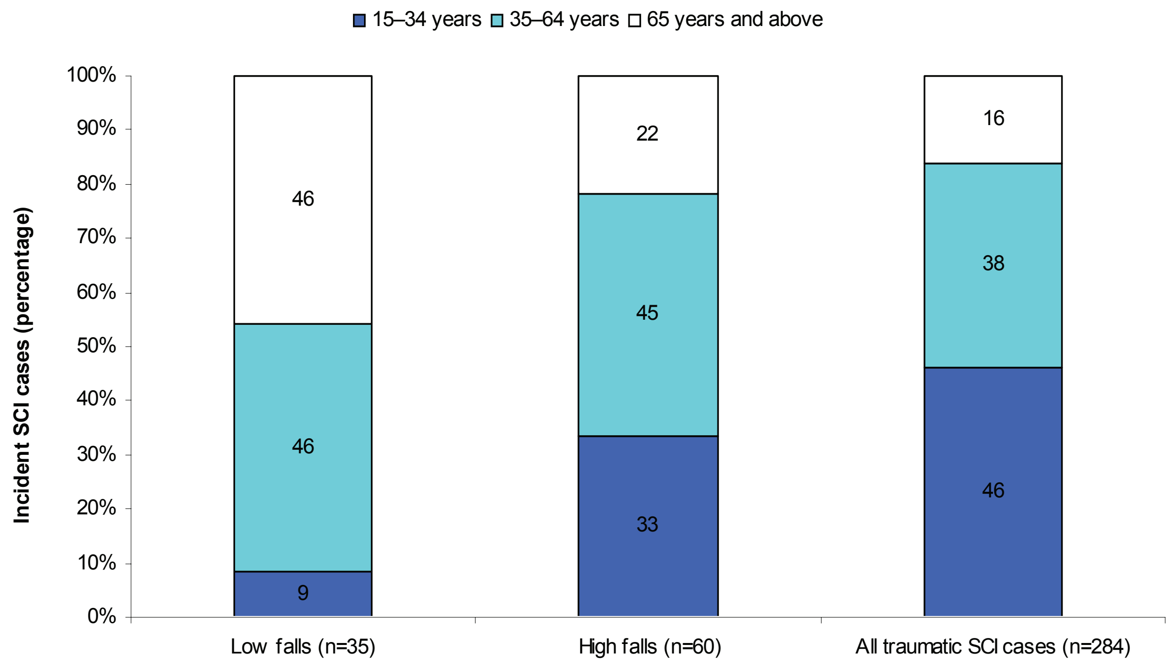


Figure 5.2: Incidence of persisting SCI from low and high falls by age group, Australia 2005–06 (percentages of each group)

5.1.5 Struck by or collision with a person or object

Eight per cent (n=22) of the SCI cases reported during 2005–06 were the result of being struck by or collision with a person or object (Table 5.1). Fifty-nine percent (n=13) of the SCI cases occurred in age group 15–34 years compared with 46% (n=131) of all traumatic SCI cases (Figure 5.3).

Twenty-four per cent (n=6) of the injuries occurred when the person was struck by machinery or crushed by falling objects while at work. In the remaining cases (n=16), injury occurred as a result of a person being hit by a large animal, impacting the ground surface, or another person's body during contact sports such as rugby (see also Section 5.2).

Fifty-five per cent of the cases (n=12) had injury to the cervical spinal segments and 8 of the remaining cases had injuries to the thoracic and lumbar spinal segments (Table 5.2). Eighteen per cent (n=4) had complete lesion of the cord.

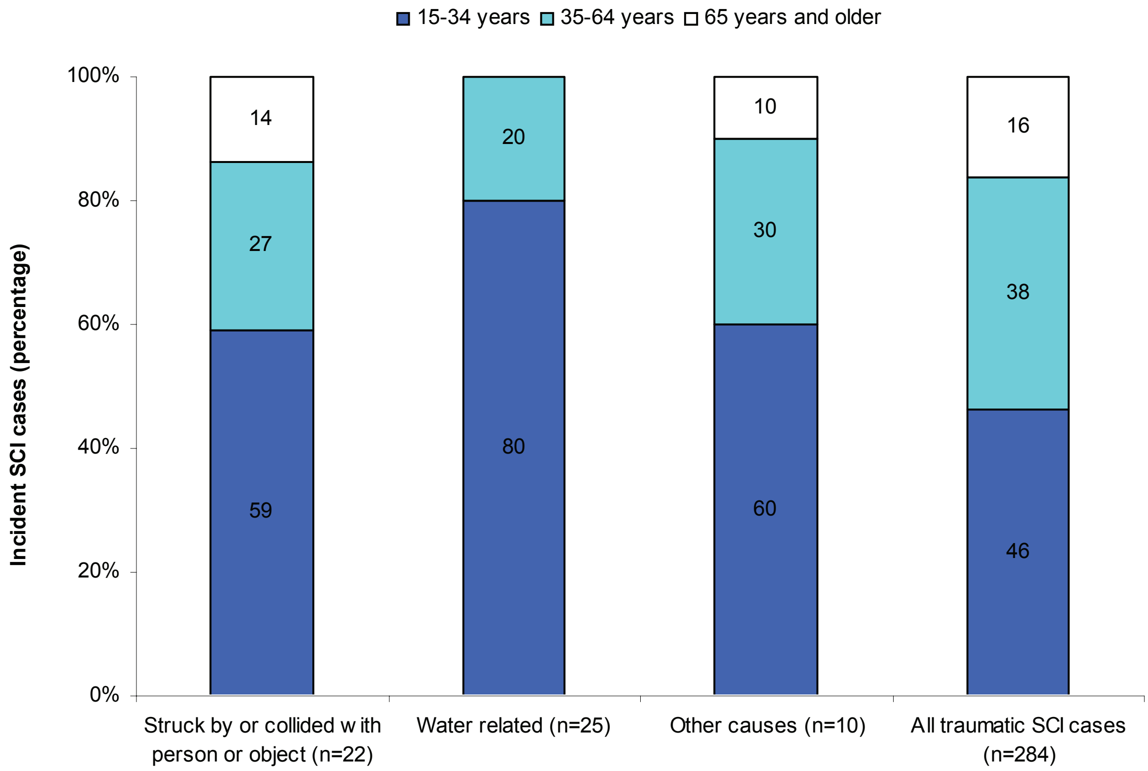


Figure 5.3: Incidence of persisting SCI from being hit or struck by object, diving or surfing, and other accidents by age group, Australia 2005–06 (percentages of each group)

5.1.6 Water-related

Water-related accidents accounted for 9% (n=25) of the SCI cases reported during 2005–06 (Table 5.1) and 80% (n=20) of these cases occurred in people under the age of 35 years (Figure 5.3).

Eighty per cent (n=19) of reported water-related SCI cases involved injury to the cervical spinal segments (Table 5.2), with over half of these cases (n=11) sustaining complete injury to the cord after they dived into a body of water probably without being aware of the depth or from water skiing or while body surfing.

Thirty-six per cent of the injuries (n=9) were the result of people diving into a body of shallow water, 12% (n=3) related to body surfing, and 24% (n=6) occurred in swimming pools.

5.1.7 Other causes

Four per cent of the SCI cases (n=10) reported during 2005–06 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 gun shots and explosives, assaults involving knives or machetes, an unknown sports related injury and injuries from complications of medical treatment. These injuries occurred over a broad range of ages, but primarily in the age group 15–34 years (Figure 5.3).

Fifty per cent of SCI cases (n=5) in the *Other causes* group sustained injury to the thoracic and lumbar spinal segments resulting in paraplegia and 5 cases had injury to cervical spinal segments (Table 5.2). Three cases had complete lesion of the cord which occurred to cervical and thoracic spinal segments.

5.2 Type of activity at time of injury

Activity at the time of injury was obtained from structured injury narratives of all traumatic cases of SCI reported during 2005–06 which were coded according to the NDS-IS, Level 1 activity categories (n=284). 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.

Twelve per cent of the SCI cases (n=35) occurred during sporting activities, and about two-thirds occurred in people under the age of 35 years. Sports-related SCI cases occurred during contact sports, motorised sports (car, trail bike and motorcross racing), water-related sports (water skiing, diving and surfing), rock climbing, equestrian sports and hang-gliding.

Fifty-four per cent of the SCIs from sporting activities occurred to the cervical spinal segments resulting in tetraplegia, with complete lesion of the cord occurring in just under a half of these cases.

Five cases of SCI occurred during the contact sport of rugby (two Rugby Union and three Rugby League players), and all resulted in injury to the cervical spinal segments The SCIs occurred during group tackles in 3 out of the 5 cases. All players were adults.

For motorised sports (n=9), over half of the cases involved injury to the thoracic and lumbar segments, with 40% of these cases having complete lesion of the cord.

In the other sports-related cases, 62% (n=16) involved injury to the cervical spinal segments and the remaining 10 cases involved injury to either the thoracic or lumber spinal segments.

Leisure activities such as diving or jumping into bodies of water, falls from trees, flying foxes or balconies, riding in boats, or while playing on the beach resulted in SCI in 26 cases, 6 of whom were intoxicated at the time (Table 5.3). The highest number of SCI cases (n=18) occurred as a result of diving into swimming pools and other bodies of water. Injury to the cervical spinal segments occurred in more than two-thirds of the leisure activity cases.

Injury to the spinal cord while working for income was also common, accounting for 15% (n=43) of the cases. Over half the cases of SCI that occurred while working (n=22) were to workers under the age of 35 years. Accidents while travelling to and from work using motor vehicles (n=10) and working while driving vehicles (n=4) resulted in tetraplegia in 28% (n=4) of the cases.

Other SCIs sustained while working for income occurred as a result of high falls from ladders, scaffolding, and from other parts of buildings on building sites (n=10), from machinery such as ‘cherry pickers’ and from agricultural machinery (n=3), or involved being hit or struck by machinery or by animals (n=5).

SCI occurred in 19 cases while people were working, but not for income, and more than two-thirds of these cases involved males aged 55 years and older. These injuries occurred primarily around the home during 'handyman' activities that resulted in falling from roofs, ladders while cleaning gutters, checking or fixing roof tiles, and falling while pruning trees or being hit by falling branches. High falls were the mechanism of injury in 84% of the cases and resulted in injury to the cervical spinal segments in 47% of the cases (n=8) and to the thoracic and lumbar spinal segments in the remaining cases.

Thirteen per cent of the SCI cases (n=36) occurred while people were involved in personal activities in their place of residence, at social venues or on the street. Seventy-six per cent of these cases (n=29) were the result of a low fall, 11% from high falls (n=4) and the remaining cases from being hit or struck by an object. Sixty-nine per cent of these cases resulted in tetraplegia. Older people were particularly at risk of SCI from low falls that occurred during activities such as preparing for sleep or rising from bed, when walking down steps or stairs, while using walking aids or when rising from chairs or couches.

Other and unspecified activity accounted for the remaining 125 cases of SCI (Table 5.3). Four of the SCIs occurred while people were being nursed or cared for and sustained injury to the cervical and lumbar spinal segments. The remaining 121 cases were categorised as *'Other/Unspecified'* as the activity at time of injury was not reported in the injury narrative and 47% (n=57) of these cases were drivers or passengers involved in motor vehicle accidents. Almost two-thirds of these cases resulted in tetraplegia.

Table 5.3: Incidence of SCI from traumatic causes by mechanism of injury and activity; Australia 2005–06 (counts and column percentages)

	Sports		Leisure		Working for income*		Other type of work		Personal activity		Other**/ Unspecified		Group Total	
Mechanism	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Traffic–Land transport: Motor vehicle occupants	***	***	***	***	8	19	***	***	***	***	55	44	63	22
Traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	***	***	***	***	5	12	***	***	***	***	38	30	43	15
Non-traffic–Land Transport: Motor vehicle occupants and unprotected road users	9	26	***	***	4	9	***	***	***	***	12	10	26	9
Low falls	***	***	***	***	***	***	***	***	27	75	***	***	35	12
High falls	9	26	5	19	16	37	16	84	4	11	10	8	60	21
Struck by or collision with a person or object	7	20	***	***	6	14	***	***	***	***	***	***	22	8
Water-related	7	20	18	69	***	***	***	***	***	***	***	***	25	9
Other	***	***	***	***	***	***	***	***	***	***	5	4	10	4
All mechanisms	**35**	**100**	**26**	**100**	**43**	**100**	**19**	**100**	**36**	**100**	**125**	**100**	**284**	**100**

*Includes travel to and from work (n=10)
** Includes Being nursed or cared for (n=4)
*** Cell counts of 3 or fewer, and related percentages, are not shown in tabulation.

6 Trends in external causes of SCI

Overall annual rates of persisting SCI in Australia have not shown marked trends during the period of operation of ASCIR (Figure 3.1) though rates have declined a little (Fig A1.1). With the availability of 11 years of ASCIR data and the completion of a case revision and audit, an opportunity now exists to analyse the data for differences in trends between major groups of SCI cases. Previous analyses considered trends in motor vehicle crashes and falls over the period 1995–96 to 2003–04 (Cripps 2006) and water-related SCI over the period 1995–96 to 2004–05 (Cripps 2006a).

The focus of this section is trends in SCI due to work-related trauma for the period 1995–96 to 2005–06. As in Chapter 5, we have included all incident cases, not only those meeting the definition of persisting SCI. Trends in some other types of SCI, such as falls, differ by age (Cripps 2006). With that in mind, data in this section are reported for two age groups: 15–64 years (common working age range) and all ages from 45 years. Before presenting results for work-related SCI at these ages, we present trends for SCI from all traumatic causes in the same age groups, to enable comparison between work-related cases and all SCI in the same age groups.

Selection of SCI cases for trend analysis was made using ASCIR records coded to the NDS-IS (*Activity when injured-type* and *Place of injury occurrence-type*), compensable status (e.g. Work Cover), and the injury event narrative. Cases were chosen that included people working for income and others working not for income (usually working around the home doing 'handyman' activities). Methods employed for analysis of trends are described in Appendix 1.

6.1 Trends in all traumatic SCI at selected ages

Figure 6.1 shows the age-adjusted incident rate of SCI from all traumatic causes for persons aged 15–64 years and those aged 45 years and above for the period 1995–96 to 2005–06.

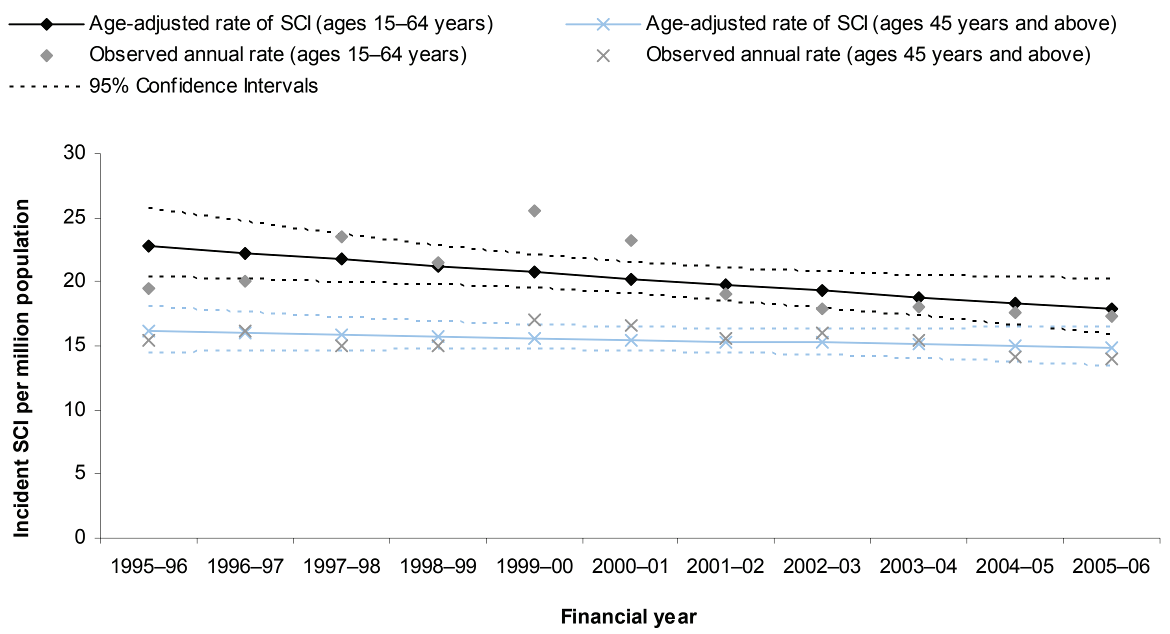


Figure 6.1: Age-adjusted incident SCI rate from traumatic causes by financial year; Australia (ages 15–64 years and 45 years and above)

The modelled 1995–96 age-adjusted incident SCI rate for the age group 15–64 years was 22.8 cases per million population (95% CI 20.3–25.7) and for the age group 45 years and above was 16.2 cases per million population (95% CI 14.5–18.0). At the beginning of the period, the rate for age-group 15–64 years was significantly higher* than the rate for the group aged 45 years and over. However, these rates converged during the study period, and did not differ significantly by its end.

Estimates from the Poisson regression modelling indicate a declining trend for 15–64 year age group. The average annual decline was 2.4% (p=0.02). No significant trend was evident for the group aged 45 years and older.

6.2 Trends in work-related traumatic SCI at selected ages

During the eleven years ending 2005–06, about 22% of incident SCI cases admitted to spinal units were due to work-related injuries. Most involved falling from a height, being hit or struck by an object, or crushed, or occurred while travelling during work or driving to or from work. Seventy-three per cent of the work-related SCI cases (n=542) happened while working for income and the remaining 27% (n=198) occurred while engaged in other work, not for income. Work-related spinal cord injury is the subject of this section.

* *p* ≤0.05 was taken to indicate statistical significance throughout this section.

6.2.1 Work-related traumatic SCI for age group 15–64 years

Age-adjusted incident rates of SCI resulting from accidents while working for income and working not for income are presented in Figure 6.2 for persons aged 15–64 years.

Estimates obtained from the Poisson regression modelling indicate significantly higher age-adjusted rates of SCI resulting from working for income during the period 1995–96 to 2005–06 for the age group 15–64 years than for the working not for income group.

The estimated age-adjusted rate at the beginning of the 1995–96 period for persons working for income was 4.2 cases per million population (95% CI 3.6–4.9) and for persons working not for income 0.8 cases per million population (95% CI 0.6–1.2).

According to the fitted model, the estimated annual age-adjusted rate of working for income accidents decreased by 2.9% per year during the 1995–96 to 2005–06 reporting period, a significant downward trend (p=0.03). No significant trend was evident for the working not for income group.

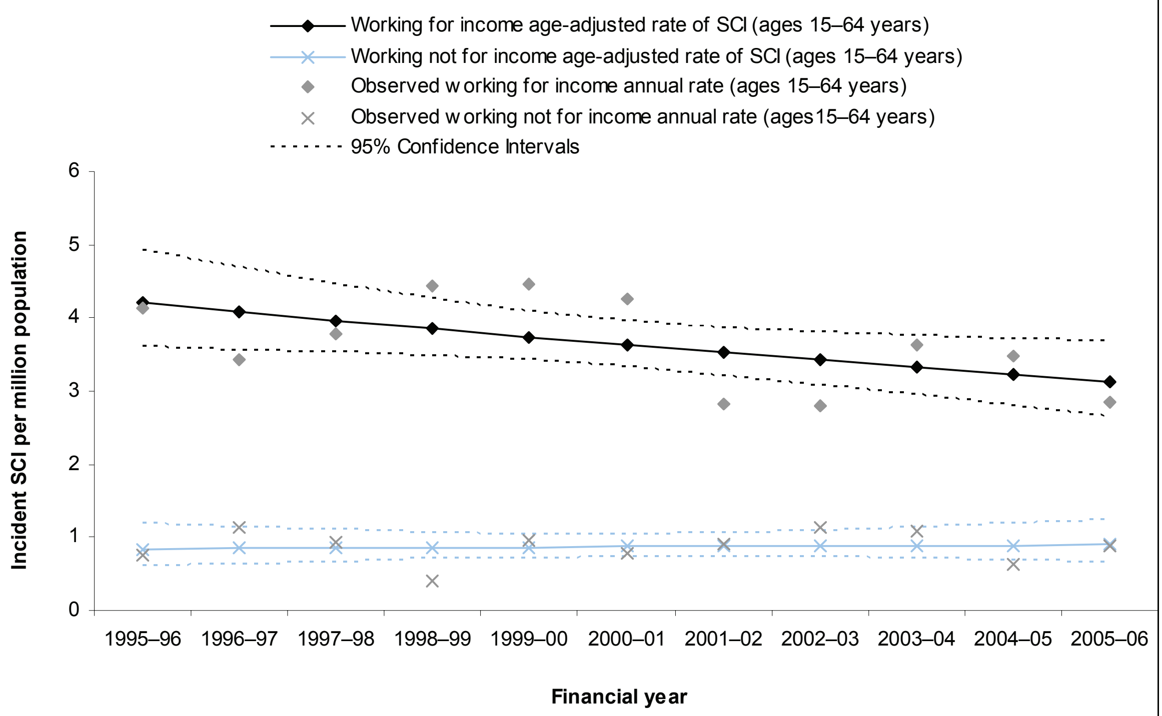


Figure 6.2: Age-adjusted incident SCI rate from work-related accidents by financial year; Australia (ages 15–64 years)

6.2.2 Work-related traumatic SCI for age group 45 years and above

Age-adjusted incident rates of SCI resulting from accidents while working for income and working not for income are presented in Figure 6.3 for persons aged 45 years and above.

Estimates obtained from Poisson regression modelling indicate no significant difference in age-adjusted rates of SCI from work-related accidents for persons aged 45 years and above during the period 1995–96 to 2005–06.

The estimated age-adjusted rate at the beginning of the 1995–96 period for persons aged 45 years and above working for income was 3.0 cases per million population (95% CI 2.3–4.0) and 1.8 cases per million population (95% CI 1.3–2.5) for persons working not for income.

According to the fitted model, the estimated annual age-adjusted rate in working for income accidents for the age group 45 years and above decreased by 4.0% per year during the period 1995–96 to 2005–06, but the trend did not reach statistical significance (p=0.08) The rate for the working not for income group showed minimal trend.

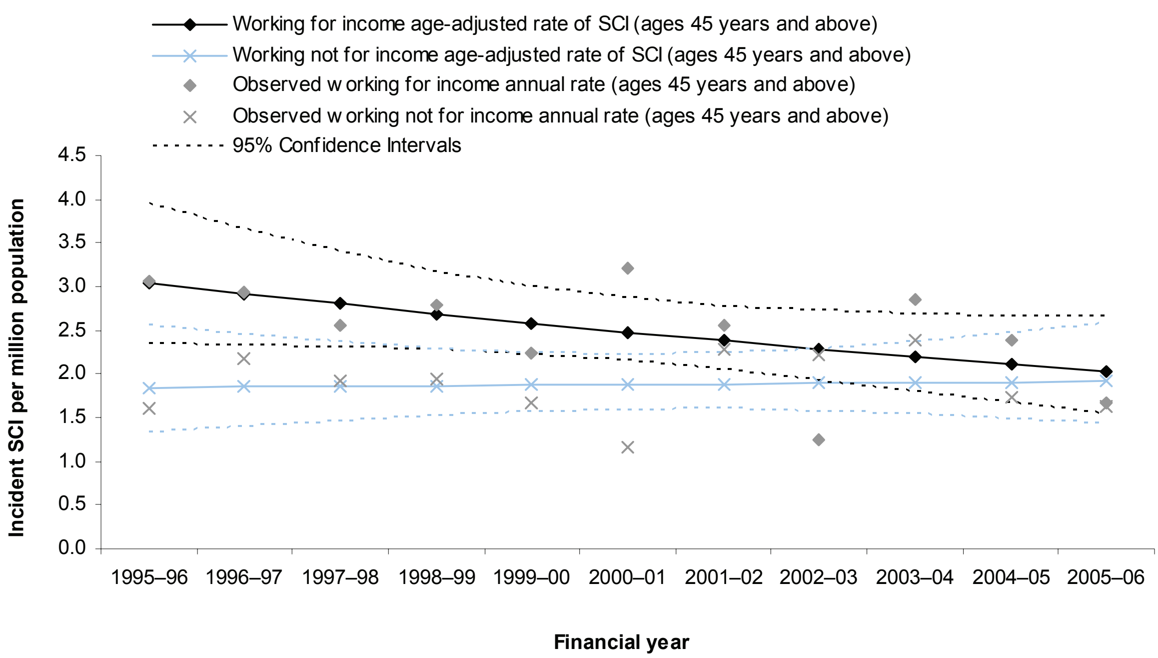


Figure 6.3: Age-adjusted incident SCI rate from work-related accidents by financial year; Australia (ages 45 years and above)

6.2.3 Discussion

In 2005–06, 6.4% of Australians experienced a work-related injury or illness while working for income during this period and almost two-thirds were men. The age group 15–24 years had the highest rate of work-related injury which declined with age, with the lowest rate occurring in people aged 55 years and above (Australian Bureau of Statistics 2006).

Based on ASCIR data, each year about 22% of new traumatic SCI cases in Australia are the result of work-related accidents. About three-quarters of these cases (n=542, an average of 49 cases per year) occurred while working for income. Two-thirds of the cases were under the age of 45 years (66%, median age of 38 years) and most were males (91%).

Work-related injury that occurred while working but not for income (usually associated with working at home, i.e. 'handyman' activities) was less frequent (about 18 cases per year) and occurred in older people (median age of 59 years) and with proportionally fewer males (80%).

Age-adjusted rates of incident SCI resulting from accidents while working for income remained significantly higher than the rates from working not for income for age groups 15–64 years over the entire period 1995–96 to 2005–06. The working for income group also had a significantly greater decline in rate than the working not for income group.

For the older age group (45 years and above), age-adjusted rates of incident SCI for both groups of work-related accidents (working for income and working not for income) were not significantly different over the entire period 1995–96 to 2005–06. For the working for income group, the decline in rate was much higher than the working not for income group, with rates during the latter part of the period becoming increasingly similar.

Almost three-quarters of SCI from work-related accidents while working for income occurred in agriculture (14%), construction (17%), mining (5%), forestry (4%), other industries (23%), such as service industries or in factories, and transport (9%) (excluding accidents while driving to or from work). People working for income in these industries had spinal injuries from high falls, being hit or struck by objects (e.g. machinery, tree branches, bales of hay), crushed by heavy objects or multiple trauma, during transport-related accidents.

People working not for income (doing 'handyman' activities around the home) particularly at older ages carry a risk of severe injury. Almost half of the cases were the result of falling from roofs or off ladders. Since the Australian population is ageing, there is a case for making people more aware of the risks associated with 'handyman' activities particularly by older people.

7 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 1

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 6 spinal units 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 (Dr 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 6 spinal units 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 6 spinal units 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. Formal investigation of ascertainment would require a case-linked, population-based study. 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.

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 2006). 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.

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

Mechanism of injury	NDS-IS Level 1 code	Notes
Traffic–Land 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.

Trend analysis

Annual incidence of SCI during 1995–96 to 2005–06 (inclusive) was estimated using a Poisson regression model. The predicted count of SCI cases for a given year was divided by the Australian population data for that year to give an incidence rate per million person years at risk. Goodness-of-fit statistics were used to test for overdispersion. If overdispersion was found, the Negative Binomial Distribution model was used instead of the Poisson regression model.

To estimate age-specific trends, numbers of incident cases were modelled as a function of year with populations as an offset. The basic Poisson regression model was $\log(\text{rate}) = \beta_o + \beta_1$ (year-1995–96), so β_o is the log of the baseline incidence rate in the first year (1995–96). The annual percentage change in incidence rate was obtained from the fitted model as $\exp(\beta_1)-1$. The level of $p \leq 0.05$ was taken to represent statistical significance.

To estimate trends using the regression of age-standardised rates of SCI, age-specific rates were multiplied by the age-specific weights of the total Australian population in the census year 2001.

Analytical methods were developed by Jesia Berry in response to the need to provide a readily accessible guide to NISU staff on appropriate statistical methods for reporting injury (Berry & Harrison 2006). Analyses were performed using Stata statistical software (Version 8).

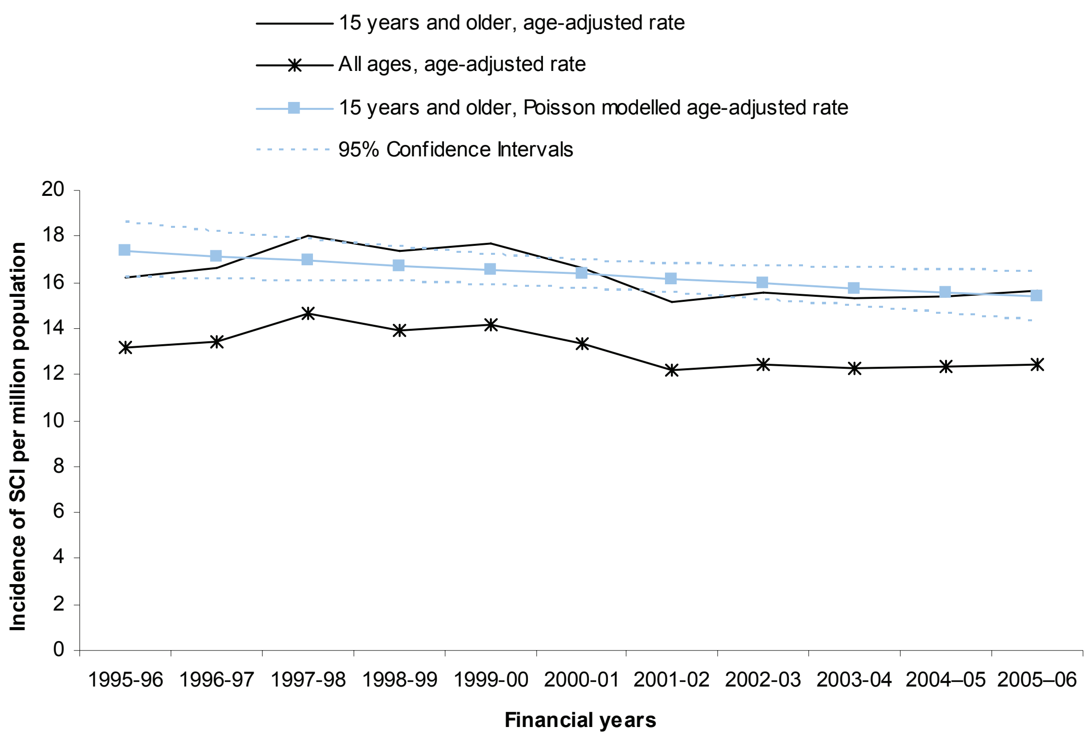


Figure A1.1: Incidence of persisting SCI from traumatic causes by financial year; Australia

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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List of Tables

List of Figures

Severe spinal cord injury (SCI) is a very debilitating injury.

This report presents information from the Australian Spinal Cord Injury Register (ASCIR) on 374 newly incident cases from trauma and disease in the year 2005–06. During the year, 284 new cases of SCI from traumatic causes were registered in Australia, an age-adjusted incidence rate of 15.7 cases per million population. The most common clinical outcome of SCI was incomplete tetraplegia (93 cases).

Transport related injuries (46%) and falls (33%) accounted for over three-quarters of the 284 cases of traumatic SCI. Cases also occurred during sport (n=35) and working for income, including travel to and from work (n=43). Falling was the most common type of event leading to traumatic SCI at older ages.

The ASCIR is a collaborative activity of the AIHW National Injury Surveillance Unit and all of the specialist spinal units in Australia.

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