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Spinal cord injury, Australia 2004–05

Raymond A Cripps

AIHW

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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 DJ 1995a).

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 2004 to 30 June 2005 (this period is abbreviated as '2004–05' in this report);

(b) clinical information on patients injured and admitted during 2004–05 who were Australian residents and acquired a persisting neurological deficit from injury to their spinal cord during 2004–05;

(c) information on external causes of SCI to Australian residents and overseas visitors who were injured and admitted during 2004–05; and

(d) trends in diving and other water-related SCI in Australian residents during the period 1995–96 to 2004–05.

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 2004–05. Section 3 reports on the incidence of 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 2004–05 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 diving and other water-related causes during the period 1995–96 to 2004–05.

This report is the 10th 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 2002–03, 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 2003–04 period (Cripps 2004). 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.35).

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 2004–05, the ASCIR was in its 11th year of operation. Almost 11,000 cases of persisting SCI have been registered.

2 Overview of SCI case registrations in 2004–05

Six spinal units (SUs), located in five states and specialising in acute management and rehabilitation of SCI patients nationally, reported 381 newly incident cases of SCI during 2004–05. 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 2004–05, 280 of the 381 new SCI cases (73%) 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=251) and excludes patients under the age of 15 years (2 cases). Section 4 deals with the clinical characteristics of all the newly incident cases of persisting SCI from trauma in the Australian population (n=251). Section 5 deals with the external causes of all traumatic cases of SCI during 2004–05 which were notified to the ASCIR (n=280).

Twenty-six per cent of the cases of SCI registered in 2004–05 were from non-traumatic causes. In these cases, SCI was secondary to medical conditions such as ischaemia (19%), cancer (18%), spinal abscesses (11%) and spinal canal stenosis (10%). Other causes of SCI were related to disc disease, myelitis, syringomyelia and medical interventions. The average age of the patients in these non-traumatic cases was 55 years (S.D.=17), compared with 40 years (S.D.=18.1) for traumatic cases.

Other cases were those patients admitted with suspected SCI or transient cord concussion but who had no lasting neurological deficit, cases of patients who were reported to have died on ward, 11 of which were due to trauma, and others who were non-residents of Australia who had their SCI in Australia (9 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 2004–05 (counts and column percentages)

Newly incident SCI case characteristics	Counts	Per cent
Traumatic causes:		
Australian residents		
Survived 90 days or to discharge, neurological deficit*	251	*66*
Survived 90 days or to discharge, no neurological deficit	9	*2*
Died on ward***	12	*3*
Non residents		
Survived to discharge, neurological deficit	8	*2*
Total traumatic causes**	**280**	***73***
Non-traumatic causes:		
Australian residents		
Survived 90 days or to discharge, neurological deficit	99	*26*
Survived 90 days or to discharge, no neurological deficit	0	*0*
Died on ward***	1	*0*
Non resident		
Survived to discharge, neurological deficit	1	*0*
Total non-traumatic causes	**101**	***27***
Total newly incident SCI cases	**381**	***100***

* These cases are the focus of Sections 3 and 4.

** These cases are the focus of Section 5.

*** Of the 13 patients who died, 12 had an SCI from traumatic causes and 8 of these trauma cases were aged 65 years and above (mean age of 73 years).

3 Incidence of persisting SCI in 2004–05

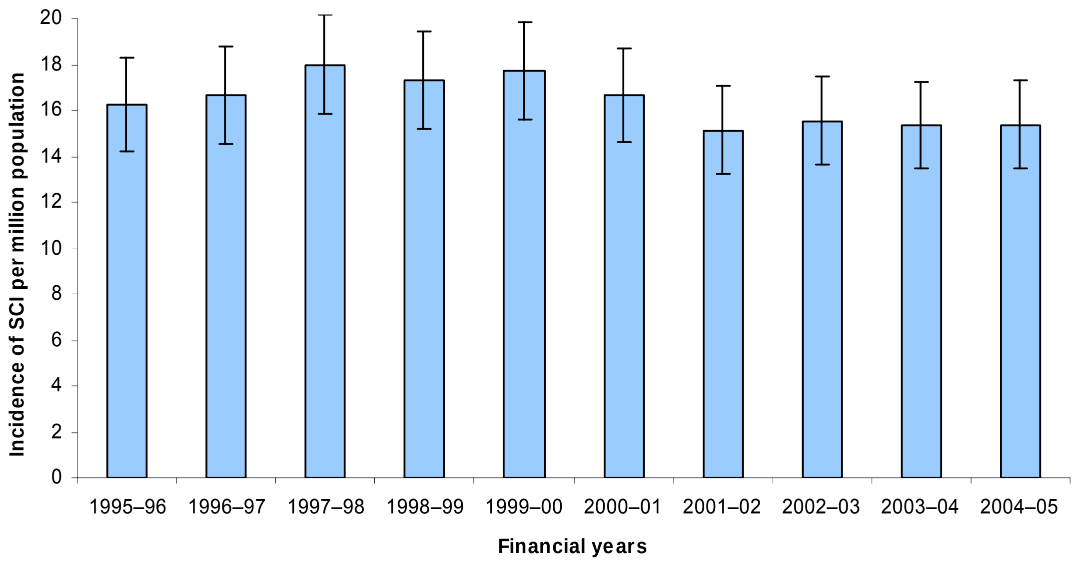
This section of the report describes the incidence of persisting SCI from traumatic causes in Australian residents during 2004–05, and trends in rates for the period commencing 1995–96. The section also includes the incidence of SCI by state and territory of usual residence and socio-demographic characteristics of these persisting SCI cases.

Given the rarity at present of neurological recovery from SCI, those patients discharged during financial year 2004–05 with a neurological deficit or having a deficit for at least 90 days after injury can be regarded as *persisting* cases of SCI. 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-one Australian residents who sustained SCI from traumatic causes during 2004–05 satisfy the case definition of persisting SCI.

3.1 Trends in persisting SCI

The age-adjusted incidence rate of persisting SCI from traumatic causes in 2004–05 in the Australian population aged 15 years and older was estimated to be 15.4 new cases per million population aged 15 years and older (Figure 3.1). The rate was higher than the rate in 2003–04 (15.3 new cases per million population), but not significantly different (95% CI=13.5–17.3). The values shown are rates for persons aged 15 years and older, standardised by the direct method to the Australian population in 2001.

As in previous reports, paediatric cases (patients under the age of 15 years) were excluded from this calculation because of the poor coverage of this group in the Register. Children with SCI are usually treated in paediatric hospitals rather than SUs. Two cases of patients aged under 15 years were registered in 2004–05 and excluded from the age-adjusted incidence rate calculation.



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 (249 cases) in 2004–05. Two cases of patients aged under 15 years were excluded.

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

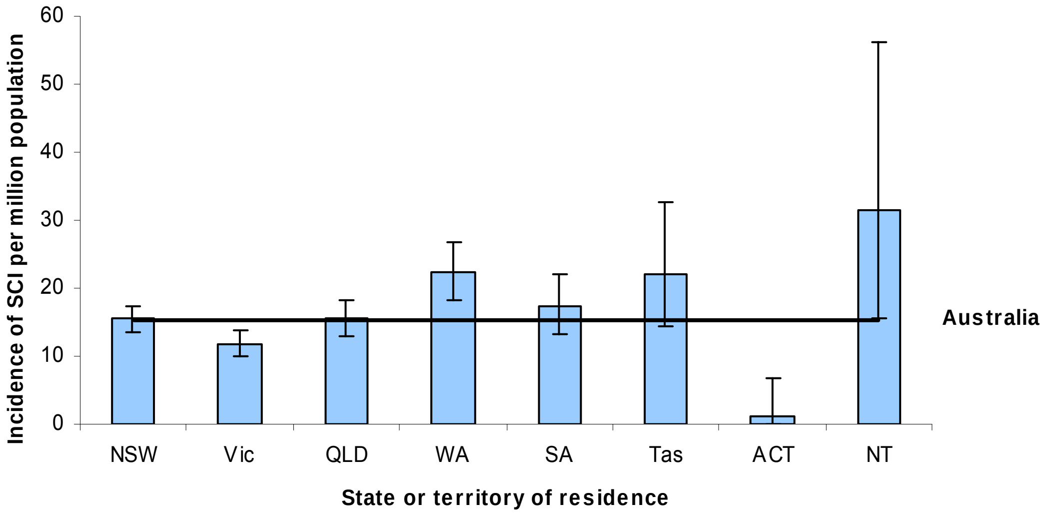
The age-adjusted rate of incidence of persisting SCI from traumatic causes by state and territory of usual residence is presented in Figure 3.2. Because of the small number of cases in some jurisdictions, incidence rates for jurisdictions are annual average rates based on cases in the three years 2002–03 to 2004–05. (This differs from calculations in reports before 2003–04.)

Three-year case counts for Tasmania (25 cases), the Australian Capital Territory (fewer than 4 cases) and the Northern Territory (11 cases) were low, which is reflected in the wide confidence intervals for these three jurisdictions.

The incidence rates range from a high of 31.4 persisting SCI cases per million of population in Northern Territory to a low of 1.2 SCI cases per million of population in the Australian Capital Territory.

Residents of Western Australia had a three-year annual average incident rate of persisting SCI that was significantly higher than the national incident rate (22.7 cases per million population versus 15.4 cases per million population). Only residents of Victoria and the Australian Capital Territory had three-year annual average incident rates of persisting SCI significantly lower than the national incident rate (11.9 cases per million population and 1.2 cases per million population, respectively, 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 2004–05 (three-year annual average rates, age 15 years and over)

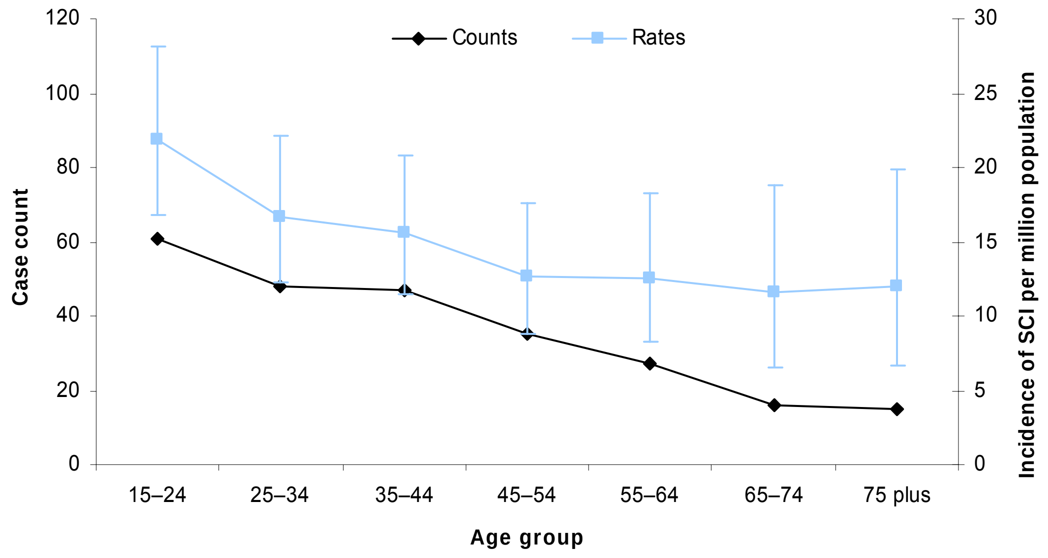
3.3 Age and sex distribution

The age distribution of cases 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=62) 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 and varied little with age for older groups.

The 95% confidence intervals on the rates, based on the Poisson distribution, indicated that in 2004–05, age-specific rates were not significantly different in any age group.

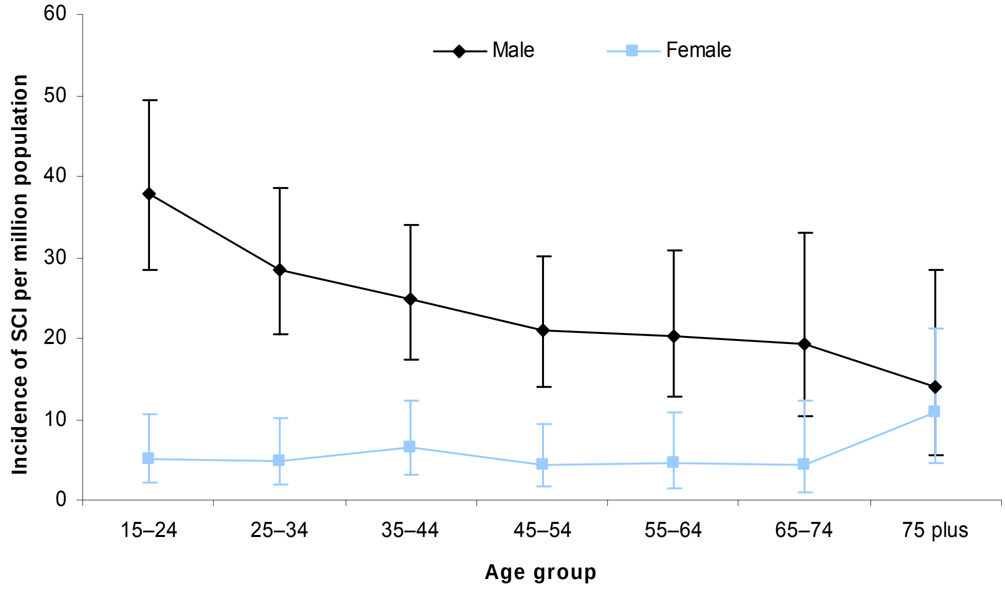
Of the cases of persisting SCI from traumatic causes, 82% were male and 18% were female. All-ages male and female rates were respectively 25.3 and 5.6 persisting SCI cases per million population, with a M:F ratio of 4.5.

Rates for males were higher than rates for females at all ages except among the age group 65 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 1.3:1 in the age group 75 years and above, to a high of 7.3:1 in the age group 15–24 years. Case counts for people aged 75 years and above were low, and accounted for about 6% of the new cases of persisting SCI from traumatic causes. A plot of age at SCI by persisting SCI cases during the operation of the ASCIR, indicates the highest number of persisting SCI cases occurred at age 21 years, followed by a decline in number of cases with decreasing age.



Note: Error bars indicate 95% confidence intervals for rates. Two cases of patients under the age of 15 years were excluded.

Figure 3.3: Incidence of persisting SCI from traumatic causes by age group, Australia 2004–05 (counts and age-specific rates)



Note: Error bars indicate 95% confidence intervals for rates. Two cases of patients aged less than 15 years were excluded.

Figure 3.4: Incidence of persisting SCI from traumatic causes by age group and sex, Australia 2004–05 (age-specific rates)

3.4 Socio-economic 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 socio-economic factors recorded in the ASCIR which may affect the outcome after rehabilitation (Tables 3.1–3.3).

Almost half of the patients were married or in a de-facto relationship and more than one-third of the patients had never married (Table 3.1). This is similar to the marital status data reported in 2003–04. Over one-half (59%) 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 12% 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.

Fifty-nine per cent of those who acquired persisting SCI were employed when their SCI occurred (Table 3.2), similar to the proportion (61%) of Australians aged 15 years and older employed in December 2004 (Australian Bureau of Statistics 2004).
Forty per cent of the people who acquired persisting SCI were working as a tradesperson, 18% were employed in professional or technical occupations, 12% were managers and the remaining 30% were either in clerical positions or labourers.

Eight per cent had a tertiary or post-graduate education, 15% had a trade qualification or apprenticeship, and about one-fifth had completed secondary school (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 2004–05 (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	55	*90*	39	*25*	0	*0*	94	*38*
Widowed	*	*	*	*	9	*29*	10	*4*
Divorced	*	*	10	*6*	*	*	12	*5*
Separated	*	*	8	*5*	*	*	9	*4*
Married (includes de facto)	5	*8*	88	*56*	16	*52*	109	*44*
Not stated	*	*	*	*	*	*	15	*6*
Group total	**61**	***100***	**157**	***100***	**31**	***100***	**249**	***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 2004–05 (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	36	*59*	108	*69*	4	*13*	148	*59*
Unemployed/Pensioner/Not available for employment-school/other/missing	25	*41*	49	*31*	27	*87*	101	*41*
Group total	**61**	***100***	**157**	***100***	**31**	***100***	**249**	***100***

Table 3.3: Educational level attained at onset of persisting SCI by age group: patients reported to ASCIR by spinal units; Australia 2004–05 (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	*	*	13	*8*	*	*	19	*8*
Trade qualification/apprentice	*	*	27	*17*	*	*	38	*15*
Diploma or certificate	*	*	9	*6*	*	*	11	*4*
Highest available secondary school level	15	*25*	18	*11*	7	*23*	40	*16*
Left school aged 16 or over	*	*	28	*17*	*	*	39	*16*
Left school aged 15 or less	*	*	22	*15*	*	*	34	*14*
Still at school	15	*25*	*	*	*	*	18	*7*
Not available/not reported	6	*10*	37	*24*	7	*23*	50	*20*
Group Total	**61**	***100***	**157**	***100***	**31**	***100***	**249**	***100***

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

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 2004–05 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 care), and incurred the injury in Australia or overseas. During 2004–05, 251 SCI cases admitted to SUs met this definition. Of these 251 cases, 12 cases were still on ward at the time of writing this report and 31 cases were discharged from initial acute care to another acute care hospital and had not completed rehabilitation. All 12 cases had injury to the cervical spinal segments and 75% of these had complete lesion of the cord.

The 251 cases whose neurological level and extent of injury are known will be the focus of the first two parts of this section of the report, and 208 cases whose discharge dates are known and who have completed rehabilitation will be used in estimating the duration of initial care (DIC) in the last part of this section.

4.1 Neurological level of injury

The neurological level of SCI at discharge is presented in Figure 4.1. The most commonly reported neurological injury was to the cervical segments (52%, n=130) and to the spinal segments at the thoraco-lumbar junction (T12 and L1, 11%, n=28).

Sixty-six per cent (n=86) of the 130 cases with injury to cervical segments had neurological loss (sensory and/or motor function) below the C4 and C5 neurological levels. This proportion was similar to the equivalent value for 2003–04 (66%, n=89).

Injury to the cord at the cervical level results in impairment or loss of motor and/or sensory function in the arms as well as in the trunk, legs, and pelvic organs. Fifty-two per cent (n=130) had an injury at the cervical level. This type of impairment is referred to as *tetraplegia*.

Forty-eight per cent (n=121) had an injury at the thoracic, lumbar or sacral levels, with an impairment or loss of motor and/or sensory function in these segments of the spinal cord. This type of impairment 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.

The most commonly injured spinal cord segments were the cervical segments, resulting in neurological loss in sensory or motor function below C4 (20%, n=49), C5 (15%, n=37), and C6 (5%, n=13) and the thoracic segment with loss below T12 (7%, n=18).

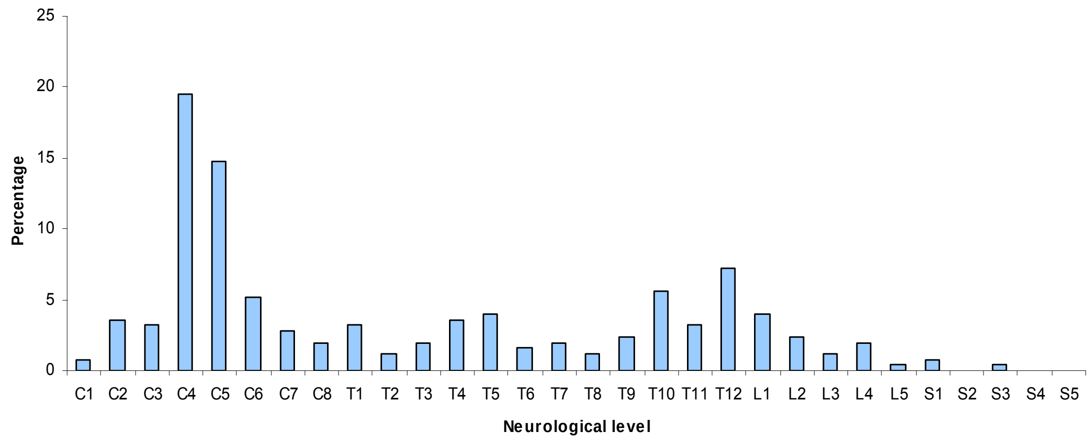


Figure 4.1: Incidence of persisting SCI from traumatic causes by neurological level at discharge; Australia 2004–05 (percentages)

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 (251 cases), the most common neurological category was incomplete tetraplegia (37%, n=92), followed by incomplete paraplegia (25%, n=64), complete paraplegia (23%, n=57) and complete tetraplegia (15%, n=38). 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 2003–04, the number of patients that suffered injury to the thoracic and lumbar spinal segments was quite different from the number reported in 2004–05. Patients with thoracic spinal injuries increased from 64 cases in 2003–04 to 93 cases in 2004–05 and lumbar spinal injuries decreased from 43 cases to 25 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. In 2004–05, cases reported with a T12 neurological level were double those reported in 2003–04 and L1 neurological levels decreased by over a third. This may be due to differences in ASIA scoring of the thoraco-lumbar junction by clinicians or other medical staff.

Table 4.1: Incidence of persisting SCI from traumatic causes by neurological level (major grouping) and extent of injury; Australia 2004–05 (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	38	*29*	54	*58*	3	*12*	0	*0*	57	*47*	95	*38*
Incomplete	92	*71*	39	*42*	22	*88*	3	*100*	64	*53*	156	*62*
Total	**130**	***100***	**93**	***100***	**25**	***100***	**3**	***100***	**121**	***100***	**251**	***100***

4.3 Duration of initial care

When this report was prepared (March 2006), 239 of the 251 cases of persisting SCI incident in 2004–05 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.

The average duration of initial care (ADIC) for all cases of SCI discharged (208 cases*) was 144 days (over four and a half months), ranging from a high of 211 days (almost seven months) for cases of complete tetraplegia to 65 days for cases of incomplete paraplegia involving injury to lumbar spinal segments.

Table 4.2: Neurological status of injury to the spinal cord of cases of persisting SCI from traumatic causes for age groups discharged during 2004–05 in Australia (counts and average duration of initial care (ADIC))

Extent of injury	Tetraplegia		Paraplegia								Total	
	Cervical		Thoracic		Lumbar		Sacral		All paraplegia			
	Count	ADIC (days)	Count	ADIC (days)	Count	ADIC (days)	Count	ADIC (days)	Count	ADIC (days)	Count	ADIC (days)
Complete	24	*211*	50	*165*	2	*281*	0		52	*169*	76	*182*
Incomplete	78	*128*	33	*142*	18	*65*	3	*73*	54	*113*	132	*122*
Total	**102**	***147***	**83**	***156***	**20**	***87***	**3**	***73***	**106**	***140***	**208**	***144***

* Of the non-discharged cases, 12 cases were still on ward at the time of writing this report and 31 cases were discharged from initial acute care to another acute care hospital and had not completed rehabilitation.

In general, patients with tetraplegia had an ADIC 39% greater than those with paraplegia (147 days, S.D.=96, versus 106 days, S.D.=90). For patients with paraplegia, the longest ADIC was reported for those with injury to the thoracic spinal segments (extent of injury cases complete and incomplete). The ADIC 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 (50 cases versus 2 cases).

Duration of initial care can vary according to the extent and neurological level of injury to the cord. In addition, other factors such as other injuries sustained at the time of the accident and the health and age of the patient may also contribute to differences in DIC. The distribution of length of stay by neurological category is presented in Figure 4.2.

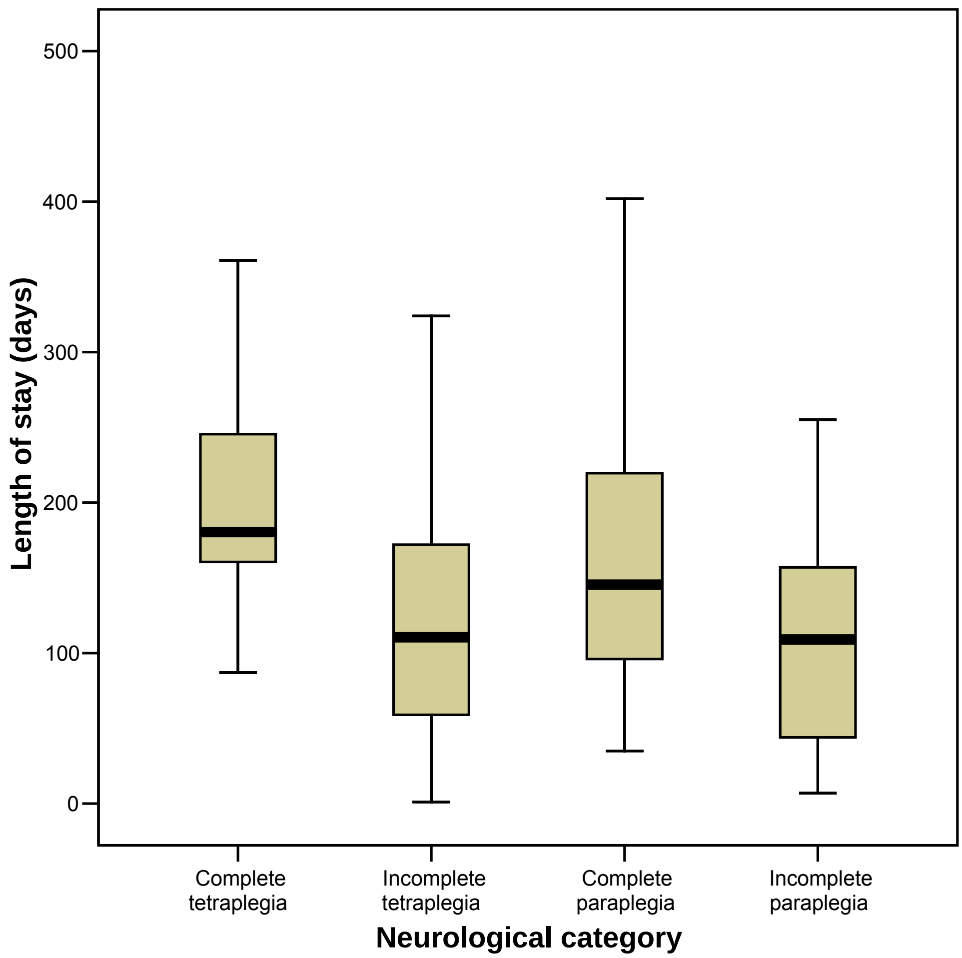


Figure 4.2: Distribution of length of stay by neurological category at discharge, Australia 2004–05 (median and percentiles [5th, 25th, 75th and 95th])

All neurological categories except incomplete paraplegia show a positive skew with the median having a lower value than the mean. All neurological categories have at least one outlier greater than the 95th percentile (incomplete tetraplegia has two outliers).

An examination of these outliers, which had prolonged length of stay (positive skew), indicated that head injuries and multiple spinal fractures were present in these cases, and complications associated with treatment occurred, which would prolong the normal length of stay.

Those with complete tetraplegia and complete paraplegia had the highest median length of stay (181 and 146 days, respectively).

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=280) 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 seven of these cases resulted in no persisting neurological loss, the aetiology was related to transport, falls and sporting 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.

Information on external causes of injury is organised differently in this report, compared to previous editions. In this edition we have described mechanisms of injury (Section 5.1) and activities being undertaken at the time of injury (Section 5.2). The latter section includes a cross-tabulation of mechanism by activity.

5.1 Mechanism of injury

The mechanisms of injury for incident cases of SCI from traumatic causes are shown in Table 5.1. SCI cases shown in Table 5.1, originally coded to NDS-IS, have been allocated to categories which reflect major mechanisms of 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 2004–05 (counts and column percentages)

Mechanism	Counts	Per cent
Traffic–Land transport: Motor vehicle occupants	67	*24*
Traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	41	*15*
Non-traffic–Land transport: Motor vehicle occupants	4	*1*
Non-traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	25	*9*
Low falls (on the same level, or from a height of less than 1 metre)	29	*10*
High falls (from a height of 1 metre or more)	53	*19*
Hit or struck by object	27	*10*
Diving or surfing	26	*9*
Other	8	*3*
All mechanisms	**280**	***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). One point of difference is the absence of any non-traffic cases at ages 65 years and older.

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 43% (n=29) of the cases. (Higher case numbers were reported in 2004–05, but 5% less than the equivalent proportion [48%, n=28] reported in 2003–04.) High speed and loss of control appear to be major contributing factors in more than half of the accidents involving rollover. Ejection of occupant occurred in 35% (n=11) of the rollover cases resulting from lack of use or failure of seat belts. Impact with a roadside hazard occurred before rollover in 16% (n=5) and a driver falling asleep at the wheel or being intoxicated was also reported in 16% (n=5) of the rollover cases.

For non-rollover motor vehicle occupant cases (n=38), impact with another vehicle was reported in 39% (n=15) of the accidents, 37% (n=14) involved an impact with roadside hazards such as poles, trees or ditches, and ejection of occupants occurred in 8% (n=3) of the cases.

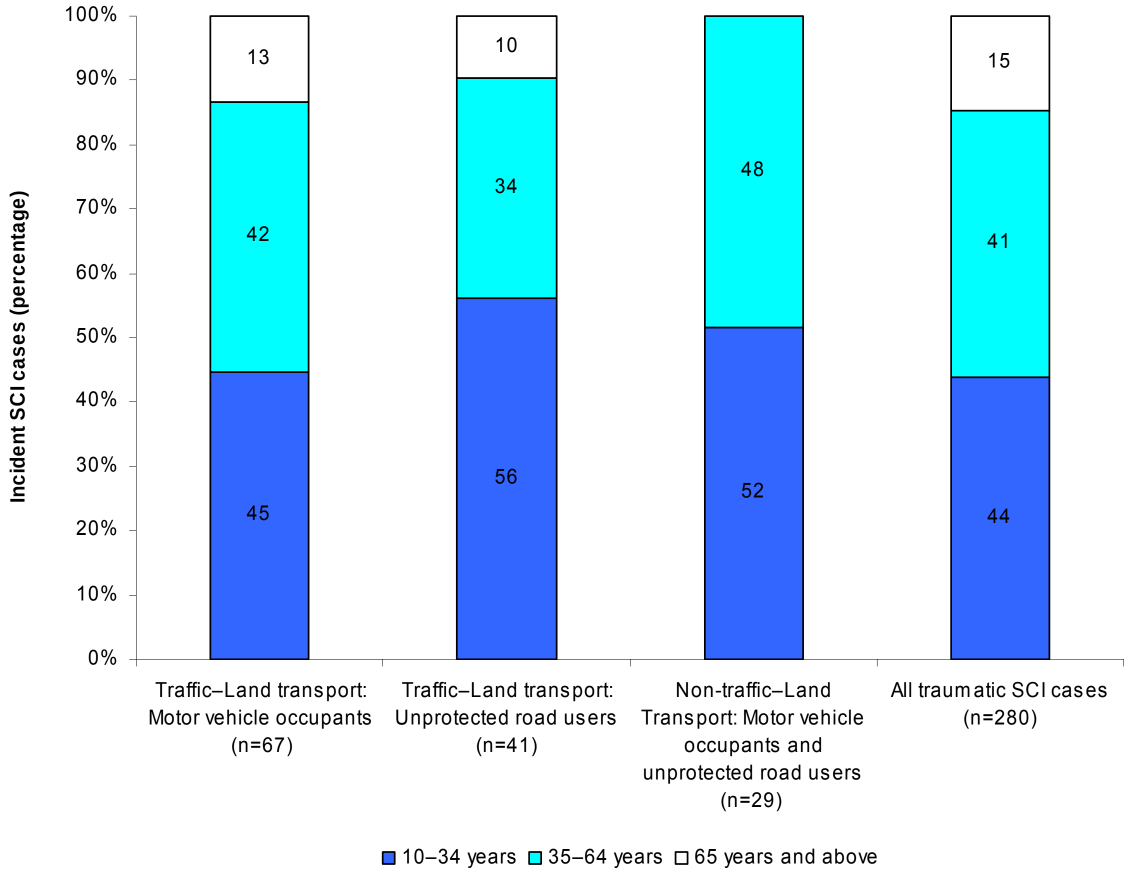


Figure 5.1: Incidence of SCI from traffic and non-traffic land transport accidents by age group, Australia 2004–05 (percentages of each group)

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, 63% (n=42) 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). One-quarter of these (n=11) had complete injury at the cervical level. Head injuries, including loss of consciousness, were also reported in 22% (n=15) 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, 2004–05 (counts and row percentages)

	Tetraplegia		Paraplegia											
	Cervical		Thoracic		Lumbar		Sacral		All paraplegia		Not reported		Total	
Mechanism	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Traffic–Land transport: Motor vehicle occupants	42	*63*	19	*28*	5	*7*	1	*1*	25	*37*	0	*0*	67	*100*
Traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	11	*27*	26	*63*	3	*7*	1	*2*	30	*73*	0	*0*	41	*100*
Non-traffic–Land transport: Motor vehicle occupants	2	*50*	2	*50*	0	*0*	0	*0*	2	*50*	0	*0*	4	*100*
Non-traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	11	*44*	12	*48*	2	*8*	0	*0*	14	*56*	0	*0*	25	*100*
Low falls (on the same level, or from a height of < 1 metre)	24	*83*	2	*7*	3	*10*	0	*0*	5	*17*	0	*0*	29	*100*
High falls (from a height of 1 metre or more)	28	*53*	18	*34*	7	*13*	0	*0*	25	*47*	0	*0*	53	*100*
Hit or struck by object	13	*48*	8	*30*	4	*15*	1	*4*	13	*48*	1	*4*	27	*100*
Diving or surfing	21	*81*	2	*8*	3	*12*	0	*0*	5	*19*	0	*0*	26	*100*
Other	1	*13*	6	*75*	0	*0*	1	*13*	7	*88*	0	*0*	8	*100*
All mechanisms	**153**	***55***	**95**	***34***	**27**	***10***	**4**	***1***	**126**	***45***	**1**	***0***	**280**	***100***

In cases involving rollover (n=29), 58% (n=17) of the occupants had injury to the cervical segments of the cord resulting in tetraplegia. Ten per cent (n=3) of these cases resulted in complete tetraplegia. The remaining rollover cases (n=12) had injury to the thoracic, lumbar and sacral spinal segments resulting in paraplegia and 33% of these cases (n=4) 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), bicyclists and pedestrians and account for 15% (n=41) of all cases of SCI during 2004–05 (Table 5.1).

Fifty-six per cent (n=23) of these unprotected road user cases in 2004–05 were in the age group 10–34 years compared with 44% (n=122) of all traumatic SCI cases. Only 10% (n=4) of unprotected road user cases were at ages 65 years or older (Figure 5.1). For these traffic-related cases, 60% (n=25) were motorcyclists, 20% (n=8) pedal cyclists and 20% (n=8) pedestrians. Motorcyclists in the 15–44 year age group (n=23) represented 92% of motorcycle cases at all ages and 14% of all SCI cases in this age group. The age profile of pedal cycle cases was similar to that of motorcyclists, with most occurring at ages 15–44 years. Unprotected road user cases over the age of 54 years (n=5) were primarily pedestrians.

The neurological level of injury in unprotected road users in traffic was cervical in 27% of the cases (n=11), and thoracic, lumbar and sacral in the remainder, resulting in a higher proportion of paraplegia (73%, n=30) than tetraplegia (Table 5.2).

Fifty-six per cent (n=23) of 2004–05 cases of SCI among unprotected road users in traffic had complete lesion of the spinal cord, with 74% (n=17) of these cases with complete lesion of the cord occurring in 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, beaches and other undeveloped recreational areas. Fifty-two per cent (n=14) of these cases were in the age group 10–34 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 and middle ages (ages 10–34 years and 35–44 years) and no elderly cases (aged 65 years and older) were involved in these accidents (Figure 5.1). Non-traffic motor vehicle occupant case numbers were low (n=4).

Fourteen percent (n=4) of the non-traffic group were motor vehicle occupants and 86% were unprotected road users. Thirty-eight per cent (n=11) of these unprotected road users were motorcyclists (drivers, no pillion passengers), 24% (n=7) were pedal cyclists and the remainder (n=7) were a pedestrian or the driver of a motorised transport device (quad bike and go-cart).

The age profile for non-traffic motorcyclists was similar to that of traffic motorcyclists, with 81% (n=13) of the cases occurring in the 15–44 year age group. Non-traffic pedal cyclists were generally younger riders (primarily aged 15–24 years of age) than traffic pedal cyclists.

For the non-traffic group, the rate of tetraplegia was, proportionally, slightly lower than for those in traffic (45% vs 49%), with injury to cervical spinal segments about as common as injury to the thoracic spinal segments (Table 5.2).

Thirty-eight per cent (n=11) of 2004–05 cases of SCI among the non-traffic group had complete lesion of the spinal cord, with 45% (n=5) of the cases with complete lesion of the cord occurring in motorcyclists as complete paraplegia.

5.1.4 Falls

Falls, both low (less than 1 metre or on the same level) and high (from 1 metre or higher), accounted for 29% (n=82) of SCI cases during the 2004–05 reporting period (Table 5.1).

Although low falls were less frequent than high falls in 2004–05 overall (29 cases versus 53 cases), they were four times more common than high falls at ages greater than 65 years (Figure 5.2). Eighty-three per cent of low falls (n=24) occurred in the patient's home while they were doing housework and other personal activities. Alcohol intoxication was reported in 7 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 83% of cases (n=24) as a result of injury to the cervical spinal segments (Table 5.2). Paraplegia was less common (n=5) and involved injury to thoracic and lumbar spinal segments. Among those aged 65 years and older, tetraplegia occurred in 79% (n=15) with extent of injury to the cervical segments of the cord being incomplete in all but two of the cases.

Sixty-five per cent (n=53) of the injurious falls were from a height of 1 metre or more. Eighty-four per cent of those whose injury resulted from falling from a height were aged between 15–64 years, compared with 34% of those involved in low falls (Figure 5.2).

Thirty-four per cent (n=18) of high falls occurred while the patients were at work (building site or factory) or while they were using mechanical devices such as 'cherry pickers' or cranes, and 25% (n=13) 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-two per cent of the people who fell during 'handyman' types of activities (n=8) were aged 54 years and above. Seventeen per cent of cases involving high falls (n=9) were by people who were intoxicated, with 5 of the cases occurring in the 15–34 year age group. Leisure and sporting activities such as base jumping, rock climbing and snow boarding accounted for 11% (n=6) of the cases.

Falling from a height resulted in tetraplegia in 53% of the cases (n=28) and in paraplegia in the remaining cases (47%, n=25) (see Table 5.2). This differs from the results reported in 2003–04 where proportionally more high falls resulted in paraplegia (65%, n=37). In the 2004–05 paraplegic cases, injury to the thoracic spinal segments was more common than injury to lower spinal segments. Fifty-one per cent (n=27) of the cases resulting from high falls had an incomplete lesion of the cord.

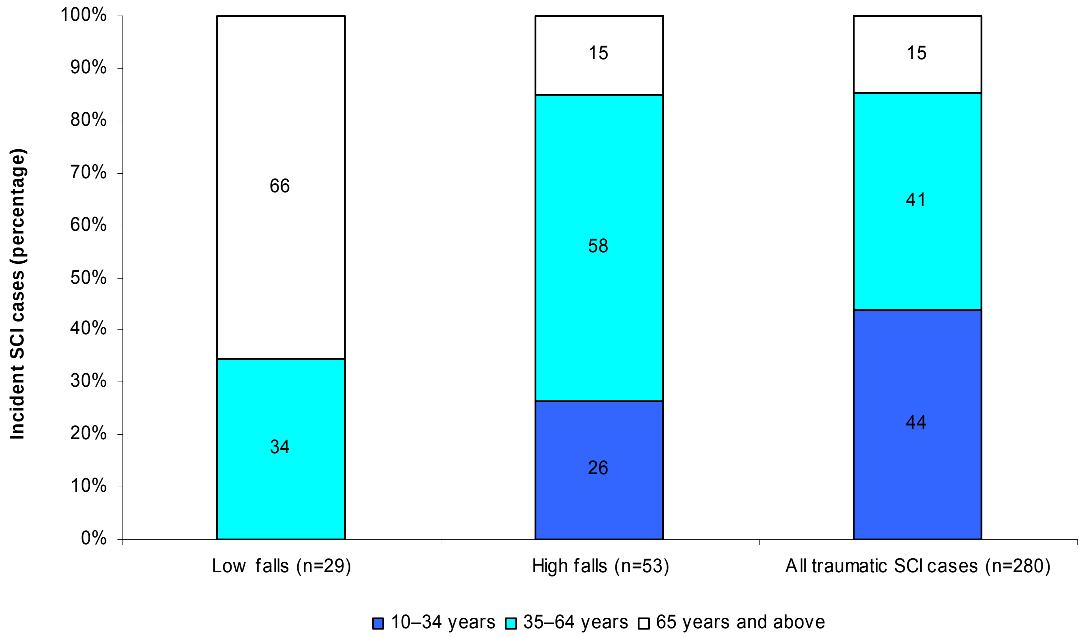


Figure 5.2: Incidence of persisting SCI from low and high falls by age group, Australia 2004–05 (percentages of each group)

5.1.5 Hit or struck by an object

Ten per cent (n=27) of the SCI cases reported during 2004–05 were the result of the person being hit or struck by an object (Table 5.1). Thirty-three per cent (n=9) of the injuries occurred when the person was struck by machinery or by falling trees while at work. Assault involving physical violence from fists, wielded objects, guns or knives resulted in 33% (n=9) of the SCI cases. In the remaining cases (n=9), injury occurred as a result of the person impacting the ground surface or another person's body during sporting activity.

Forty-eight per cent of the cases (n=13) had injury to the cervical spinal segments and the remaining cases had injuries to the thoracic, lumbar and sacral spinal segments (Table 5.2). Tetraplegia and paraplegia cases were proportionally similar and 30% (n=8) had complete lesion of the cord.

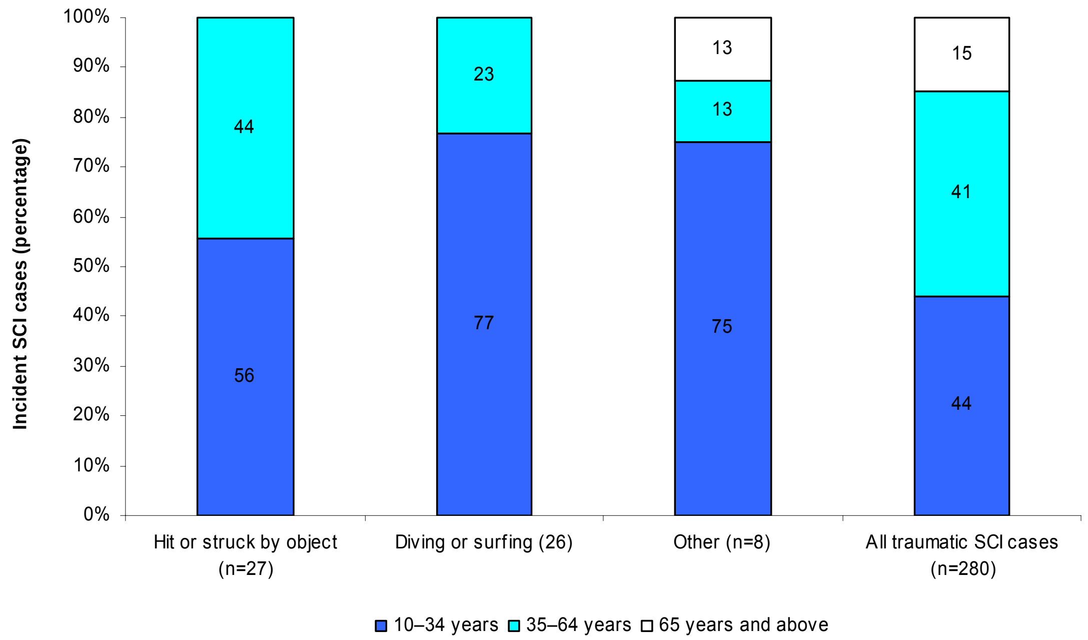


Figure 5.3: Incidence of persisting SCI from being hit or struck by object, diving or surfing, and other accidents by age group, Australia 2003–04 (percentages of each group)

5.1.6 Diving or surfing

Diving or surfing accidents accounted for 9% (n=26) of the SCI cases reported during 2004–05 (Table 5.1), and 71% (n=20) of these occurred in people aged under 35 years (Figure 5.3).

Eighty-one per cent (n=21) of reported water-related SCI cases involved injury to the cervical spinal segments (Table 5.2), with 27% of these sustaining complete injury to the cord after they dived into a body of water probably without being aware of the depth.

Fifty per cent of the injuries (n=13) were the result of people diving into a body of shallow water, 19% (n=5) related to surfing, and 12% (n=3) occurred in swimming pools.

5.1.7 Other causes

Three per cent of the SCI cases (n=8) reported during 2004–05 had an external cause of injury that was not included in the other major groups of external causes detailed in Table 5.1. These injuries occurred over a broad range of ages, but primarily in the age group 10–34 years (Figure 5.3).

These other external causes of injury to the spinal cord included crushing, lifting heavy objects, and electrocution, with the remaining cases in this group sustaining an SCI as a result of complications of surgical or medical care, or from self-inflicted injury.

Eighty-eight per cent of SCI cases (n=7) in the *Other causes* group sustained injury to the thoracic and sacral spinal segments resulting in paraplegia. In only one case was there injury to the cervical spinal segments (Table 5.2). All complete lesions of the cord (n=2) occurred to the 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 2004–05 which were coded according to the NDS-IS, Level 1 activity categories (n=280). 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 of responsibility 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.

Sixteen per cent of the SCI cases (n=44) occurred during sporting activities, and about 75% occurred in people under the age of 35 years. Sports-related SCI cases occurred during contact sports, motorised sports (trail bike and motorcross racing), pedal cycle racing, water-related sports (diving and surfing), snow-related sports (skiing and snow boarding), rock climbing, equestrian sports (including racing), base-jumping and hang-gliding.

Sixty-two 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 50% of these cases.

The only contact sport in which SCIs occurred was rugby (n=4), and all resulted in injury to the cervical spinal segments The SCIs occurred during a group tackle in 3 out of the 4 cases, and two of those injured players were under the age of 19 years.

For motorised sports (n=10), 60% of the cases involved injury to the thoracic and lumbar segments, with 50% of these having complete lesion of the cord.

In the other sports-related cases, 60% (n=20) involved injury to the cervical spinal segments and the remaining 10 cases involved injury to either the thoracic or lumber spinal segments.

The highest number of SCI cases (n=98) occurred during leisure activities (Table 5.3), with 70% (n=69) of these cases being aged under 45 years. Eighty per cent of the SCIs (n=78) occurred while motor vehicles (motor cars and motorcycles) were being driven on highways or roads, and resulted in injury to the cervical spinal segments in 40% of these cases. Leisure activities such as jumping into bodies of water, riding in boats, or riding motorcycles on the beach resulted in SCI in 16 cases.

Injury to the spinal cord while working for income was also common, accounting for 17% (n=47) of the cases. Accidents while travelling to and from work using motor vehicles (n=10) and working while driving vehicles (n=8) resulted in tetraplegia in 47% (n=8) of the cases.

Other work-related SCIs occurred as a result of high falls from ladders, scaffolding and roofs, and from other parts of buildings on building sites (n=11), and from machinery such as ‘cherry pickers’ and cranes. Other work-related injuries involved being hit or struck by machinery or by trees (n=7).

SCI occurred in 15 cases while people were working, but not for income, and all these cases involved males aged 45 years and older. These injuries occurred primarily around the home during ‘handyman’ activities that resulted in falling through roofs, falling off ladders and falling off roofs while carrying construction material, attempting to prune trees/vines from roofs or while cleaning gutters. High falls were the mechanism of injury in 80% of the cases and resulted in injury to the cervical spinal segments in 47% of the cases (n=7) 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 around the home, at social venues or on the street. Seventy-two per cent of these cases (n=29) were the result of a low fall, 25% of high falls and the remaining cases from the person being hit or struck by an object. Eighty-one per cent of these cases resulted in tetraplegia. Older people were particularly at risk of SCI from low falls that occurred during vital activities such as preparing for sleep, washing, or walking down steps or stairs.

Other and unspecified activity accounted for the remaining 40 cases of SCI (Table 5.3). Seven of the SCIs occurred while people were being nursed or cared for, and who, as a result of falling, sustained injury to the cervical, thoracic or lumbar spinal segments. The remaining 33 cases were categorised as *'Other/Unspecified'* as the activity at time of injury was not reported in the injury narrative. Fifty-nine per cent of these cases resulted in paraplegia.

Table 5.3: Incidence of SCI from traumatic causes by mechanism of injury and activity; Australia 2004–05 (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	0	*0*	55	*56*	10	*21*	0	*0*	0	*0*	2	*5*	67	*24*
Traffic–Land transport: Unprotected road users (motorcyclists, pedal cyclists, pedestrians)	1	*2*	24	*24*	3	*6*	0	*0*	0	*0*	13	*33*	41	*15*
Non-traffic–Land Transport: Motor vehicle occupants and unprotected road users	16	*36*	5	*5*	5	*11*	1	*7*	0	*0*	2	*5*	29	*10*
Low falls	0	*0*	0	*0*	0	*0*	0	*0*	26	*72*	3	*8*	29	*10*
High falls	3	*7*	3	*3*	18	*38*	12	*80*	8	*22*	9	*23*	53	*19*
Hit or struck by object	8	*18*	0	*0*	9	*19*	1	*7*	2	*6*	7	*18*	27	*10*
Diving or surfing	15	*34*	11	*11*	0	*0*	0	*0*	0	*0*	0	*0*	26	*9*
Other	1	*2*	0	*0*	2	*4*	1	*7*	0	*0*	4	*10*	8	*3*
All mechanisms	**44**	***100***	**98**	***100***	**47**	***100***	**15**	***100***	**36**	***100***	**40**	***100***	**280**	***100***

*Includes travel to and from work (n=11)

** Includes Being nursed or cared for (n=7)

6 Trends in external causes of persisting SCI

Overall annual rates of persisting SCI in Australia have not shown marked trends during the period of operation of ASCIR (Figure 3.1). With the availability of 10 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 cases. A previous analysis of trends considered trends in motor vehicle crashes and falls over the period 1995–96 to 2003–04 (Cripps 2005). The focus of this section is overall trends in total persisting SCI and trends in water-related SCI in Australia over the period 1995–96 to 2004–05. Selection of persisting SCI cases for trend analysis was made using ASCIR records coded to the NDS-IS and the injury event narrative. Methods employed for analysis of trends are described in Appendix 1.

6.1 Trends in persisting SCI

Figure 6.1 shows the age-adjusted incident rate of SCI from traumatic causes for persons aged 15 years and above and those aged from 15–44 years for the period 1995–96 to 2004–05. These two age groups were chosen to provide age-adjusted incident SCI rates for all ages for which ASCIR provides good coverage (15 years and above) and for a younger sub-group, who are most at risk of water-related SCI.

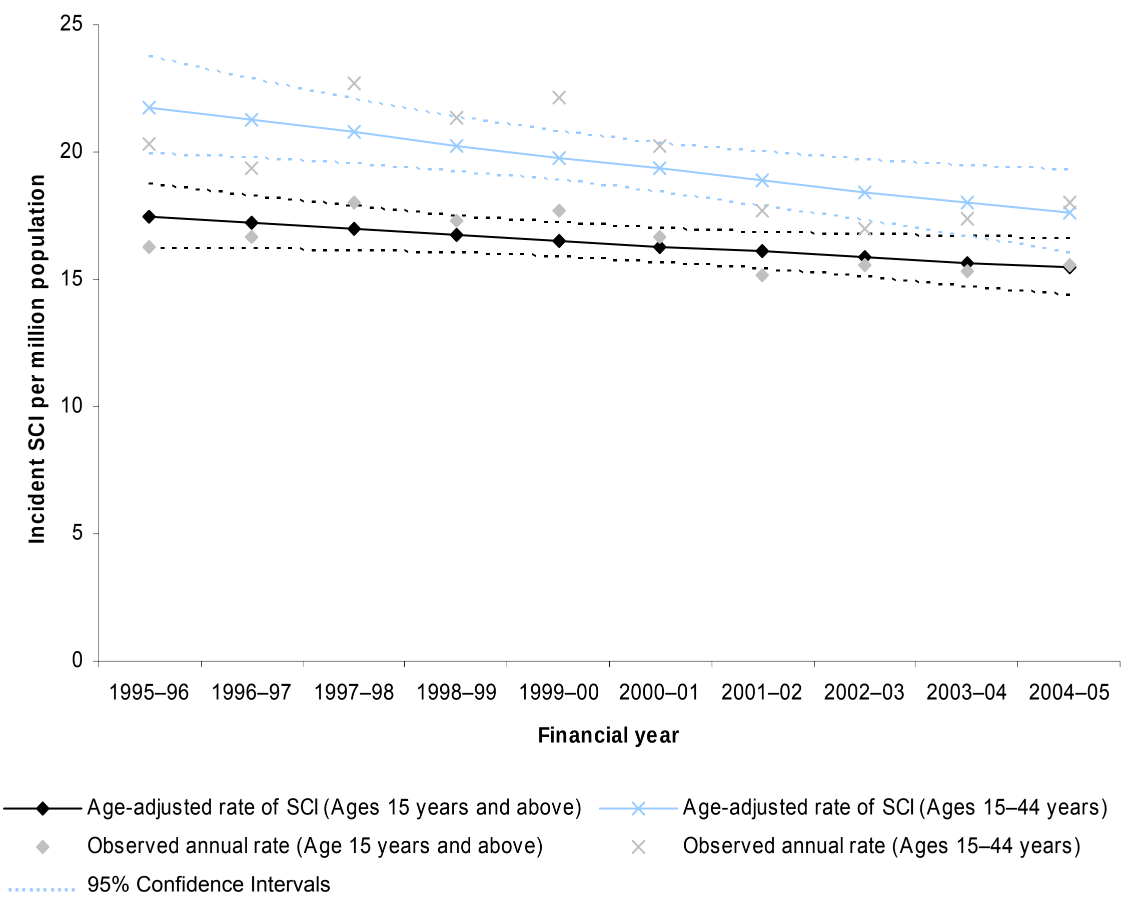


Figure 6.1: Age-adjusted incident SCI rate from traumatic causes by financial year; Australia (ages 15 years and above and 15–44 years)

The 1995–96 age-adjusted incident SCI rate for the age group 15 years and over was 17.4 cases per million population (95% CI 16.2–18.7) and for the younger group (15–44 years) was 21.8 cases per million population (95% CI 19.9–23.7). The rate at the beginning of the period for age-group 15–44 years was significantly higher* than the rate for those aged 15 years and over, but not significantly higher after 2002–03.

Estimates from the Poisson regression modelling indicate a declining trend for both age groups considered. The average annual decline was 1.3% for age group 15 years and above and 2.3% for the age group 15–44 years.

6.2 Trends in water-related SCI

Each year, about 9% of incident SCI admissions to spinal units are caused by water-related accidents, involving diving (excluding scuba, deep sea diving, etc.), surfing (including being dumped by waves), water skiing and boating accidents, and jumping into bodies of water. Eighty-nine per cent of the water-related SCI cases were the result of diving and surfing accidents and will be the focus of this section.

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* $p \leq 0.05$ was taken to indicate statistical significance throughout this section.

6.2.1 Diving-related SCI

Age-adjusted incident rates of SCI resulting from diving accidents are presented in Figure 6.2 for persons aged 15 years and above and for those aged 15–44 years.

Estimates obtained from the Poisson regression modelling indicate significantly higher age-adjusted rates of SCI resulting from diving accidents during the period 1996–97 to 2002–03 for the age group 15–44 years than for the age group 15 years and above.

The estimated age-adjusted rate at the beginning of the 1995–96 period for persons aged 15 years and above was 0.9 cases per million population (95% CI 0.7–1.3) and for persons aged 15–44 years 1.7 cases per million population (95% CI 1.3–2.4).

According to the fitted model, the estimated annual age-adjusted rate of diving accidents for the age group 15 years and above decreased by 3.4% per year during the 1995–96 to 2004–05 reporting period, a slightly lower annual rate of decrease than that for the younger age group (3.6%). The annual decrease of 3.4% in rate of SCI from diving accidents was not a significant downward trend (p=0.246).

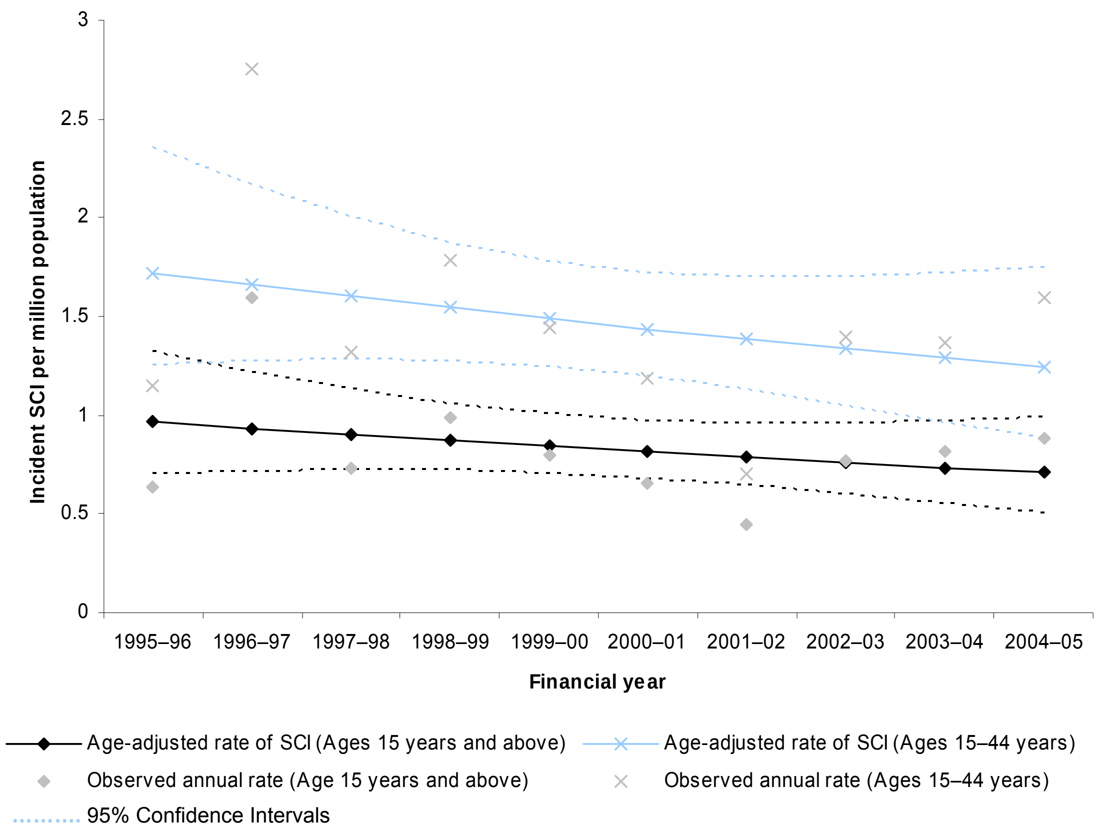

Figure 6.2: Age-adjusted incident SCI rate from diving accidents by financial year; Australia (ages 15 years and above and 15–44 years)

6.2.2 Surfing-related SCI

Age-adjusted incident rates of SCI resulting from surfing accidents are presented in Figure 6.3 for persons aged 15 years and above and for those aged 15–44 years.

Estimates obtained from Poisson regression modelling indicate no significant difference in age-adjusted rates of SCI from surfing accidents between age groups (15 years and above and 15–44 years) during the period 1995–96 to 2004–05.

The estimated age-adjusted rate at the beginning of the 1995–96 period for persons aged 15 years and above was 0.4 cases per million population (95% CI 0.2–0.6) and 0.5 cases per million population (95% CI 0.3–0.9) for the younger age group.

According to the fitted model, the estimated annual age-adjusted rate in surfing accidents for the age group 15 years and above increased by 1.7% per year during the period 1995–96 to 2004–05, while the rate for the younger age group decreased at an annual rate of 0.9%. The annual increase of 1.7%% in rate of SCI from surfing accidents was not a significant upward trend (p=0.703).

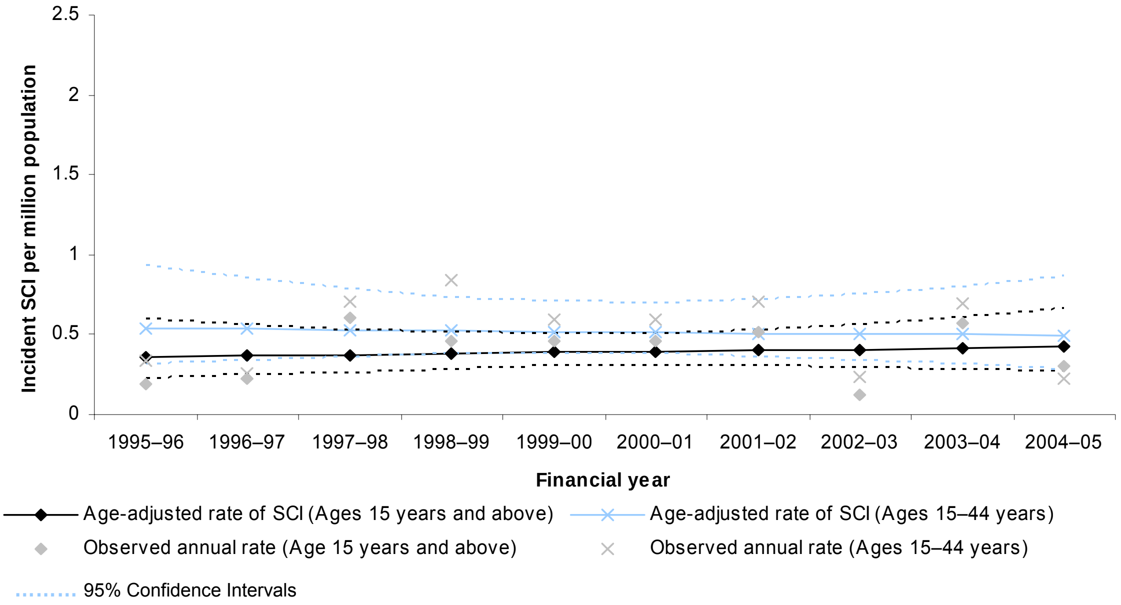

Figure 6.3: Age-adjusted incident SCI rate from surfing accidents by financial year; Australia (ages 15 years and above and 15–44 years)

6.2.3 Discussion

Age-adjusted rates of incident SCI resulting from diving accidents remained significantly higher than the rates of those incident SCI resulting from surfing accidents for age group 15 years and above over the period 1995–96 to 2002–03, but not for the period 2003–04 to 2004–05. For the younger age group, incident SCI rates for diving accidents remained significantly higher than the rates for surfing accidents over the entire period 1995–96 to 2004–05.

Although neither the downward trend in diving, nor the increasing trend in surfing-related SCI were significant over the period 1995–96 to 2004–05, the increase in surfing-related SCI may warrant an increase in focus on this sport by people involved in water-related safety programs as well as continued safety education and injury prevention programs to reduce diving accidents. Diving and surfing-related SCI cases are of particular concern because 95% (n=190) of the people injured during the last 10 years of reporting had an injury to the cervical spinal segments resulting in tetraplegia. Thirty per cent of these people with tetraplegia had complete lesion of the spinal cord, which is likely to affect their level of independence after rehabilitation, and contribute to a greater health burden in terms of service needs and medical care for this group living with SCI.

Although the incidence of diving and surfing accidents resulting in SCI is low (about 20 each year), both surfing and diving into a body of water of apparently unknown depth carry a risk of severe injury. People engaged in water-related activities need to be aware of the hazards associated with diving and surfing so that through education and other prevention programs the number of these severe and life-changing injuries can be reduced.

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8 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), an external 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, 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 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 June 30). Ascertainment of traumatic SCI cases is high and these cases are the focus of the report. 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 (Australian Bureau of Statistics). 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.

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.

Trend analysis of external causes of SCI

Annual incidence of SCI during 1995–96 to 2004–05 (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(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.

Analyses were performed using Stata statistical software (Version 8).

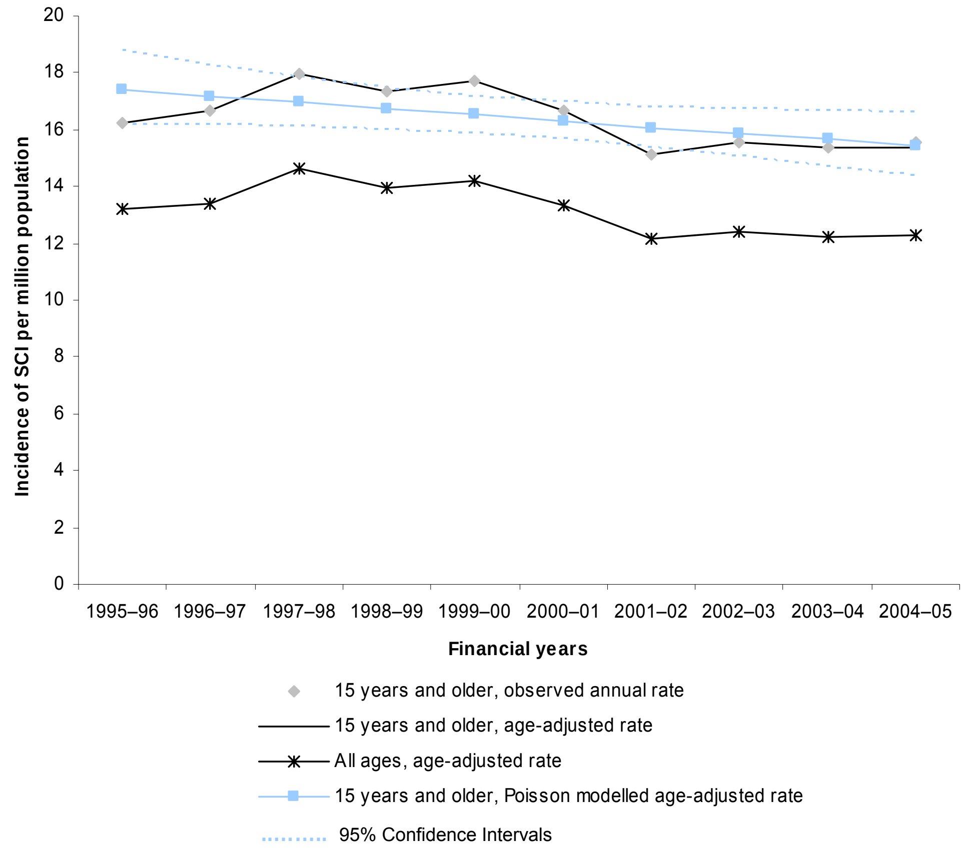

Figure A1.1: Incidence of SCI from traumatic causes by financial year; Australia

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'.

Figure 6.1 presents results of Poisson regression of age-specific rates that have been age standardised by multiplying these rates by the age-specific weights for persons in the 2001 Australian standard population. These values are shown in Figure A1.1 as the series labelled '15 years and older, observed annual rate'.

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'.

INJURY RESEARCH & STATISTICS

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

This report presents information from the Australian Spinal Cord Injury Register (ASCIR) on 381 newly incident cases from trauma and disease in the year 2004–05. During the year, 280 new cases of SCI from traumatic causes were registered in Australia, an age-adjusted incidence rate of 15.4 cases per million population. The most common clinical outcome of SCI was incomplete tetraplegia (92 cases).

39% of cases were related to road transport, and 9% to water-related activities. Cases also occurred during sport (n=44) and working for income, including travel to and from work (n=47). 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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