1 Introduction

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

During the 1940s–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 newly incident cases of SCI are added to an estimated prevalent SCI population of about 8,500 cases. Based on 1988 cost estimates (Walsh et al. 1995); (Walsh 1988), the ongoing costs associated with the long-term care of the prevalent population of about 8,500 is estimated to be about A$285 million per year.

The prevention and control of injury is one of seven National Health Priority Areas for Australia (DHFS & AIHW 1998) and one of the performance indicators for this area is the annual incidence rate of persistent SCI from traumatic causes.

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 admitted to all six spinal units and reported to the National Injury Surveillance Unit (NISU) during the period 1 July 2003 to 30 June 2004 and (b) clinical information on cases admitted during 2003–04 who had a persisting neurological deficit from injury to their spinal cord.

Section two of the report is an overview of case registration and reporting by spinal units with a particular focus on the characteristics of the cases admitted during 2003–04. Section three reports on the incidence of SCI, including trends and the incidence of SCI by state and territory of usual residence and a description of socio-demographic characteristics of the traumatic cases. Sections four and five provide information on factors associated with the SCI event and an analysis of trends in SCI from several major causes. The last section provides a clinical description of SCI cases injured and treated in 2003–04 who had a persisting neurological deficit at discharge from rehabilitation.

This report is the ninth statistical report based on case registration data holdings of the Australian Spinal Cord Injury Register (ASCIR). Previous 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 1999–00 to 2001–02, were reported in the AIHW's *Injury Research and Statistics Series*. The previous report in this series was based on ASCIR data from the 2002–03 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.

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.

The ASCIR, in 2003–04, was in its tenth year of operation and has about 10,500 cases of persisting SCI registered.

2 Overview of SCI case registrations in 2003–04

Six spinal units (SUs) located in five states and specialising in acute management and rehabilitation of SCI patients nationally reported 382 case registrations during the financial year 2003–04. These spinal units treat SCI patients Australia-wide and patients from states and territories that have no spinal units (e.g. Tasmania, Northern Territory and the Australian Capital Territory) are normally sent to the nearest available spinal unit in other states for treatment. Treatment of newly incident SCI cases comprises only part of the work-load of SUs. These SUs also provide out-patient and outreach care as well as inpatient care for those readmitted for various reasons, sometimes long after the date of injury. Complete enumeration of cases was confirmed by Directors or Staff at each SU and a quality assurance audit of ASCIR data was completed prior to data analysis. Operation and management of ASCIR and data issues are summarised in Appendix 1.

In the year 2003–04, 247 of the 382 new SCI cases (65%) had their SCI from traumatic causes (Table 2.1) and will be the focus of this report.

Twenty-three per cent of the cases were from non-traumatic SCI causes. For these cases, SCI was secondary to medical conditions such as cancer (31%), spinal abscesses (16%) and spinal canal stenosis (11%). Other causes of SCI were related to disc disease, ischaemia, and medical interventions. The average age of the non-traumatic cases was 57 years (S.D.=17).

Other cases were cases admitted with suspected SCI or transient cord concussion but had no lasting neurological deficit and cases who were reported to have died on ward. The last group of cases were non-residents of Australia who had their SCI overseas (3 cases) and non-Australian residents who had their SCI in Australia (5 cases). The number of non-residents who suffered an injury to the spinal cord (n=5 cases) was similar to the number reported in previous years. This group is omitted from Australia incidence rate calculations, since the denominator is the population of usual residents of Australia.

Table 2.1: Case registrations reported to ASCIR by spinal units; Australia 2003–04 (counts and column percentages)

Newly incident SCI case characteristics	Counts	Per cent
Traumatic causes:		
Australian residents		
Survived 90 days or to discharge, neurological deficit	247*	65
Survived 90 days or to discharge, no neurological deficit	23	6
Died on ward**	12	3
Non residents		
Survived to discharge, neurological deficit	7	2
Non-traumatic causes:		
Australian residents		
Survived 90 days or to discharge, neurological deficit	88	22
Survived 90 days or to discharge, no neurological deficit	4	1
Died on ward	0	
Non resident		
Survived to discharge, neurological deficit	1	0
Total	**382*** **	**100**

* These cases are the focus of this report.

** All cases who died had an SCI from traumatic causes; 8 of these cases were aged 65 years and above, with a mean age of 71 years.

*** Six additional cases (2 traumatic and 4 non-traumatic) were reported by one spinal unit. Case details were not provided.

3 Incidence of persisting SCI in 2003–04

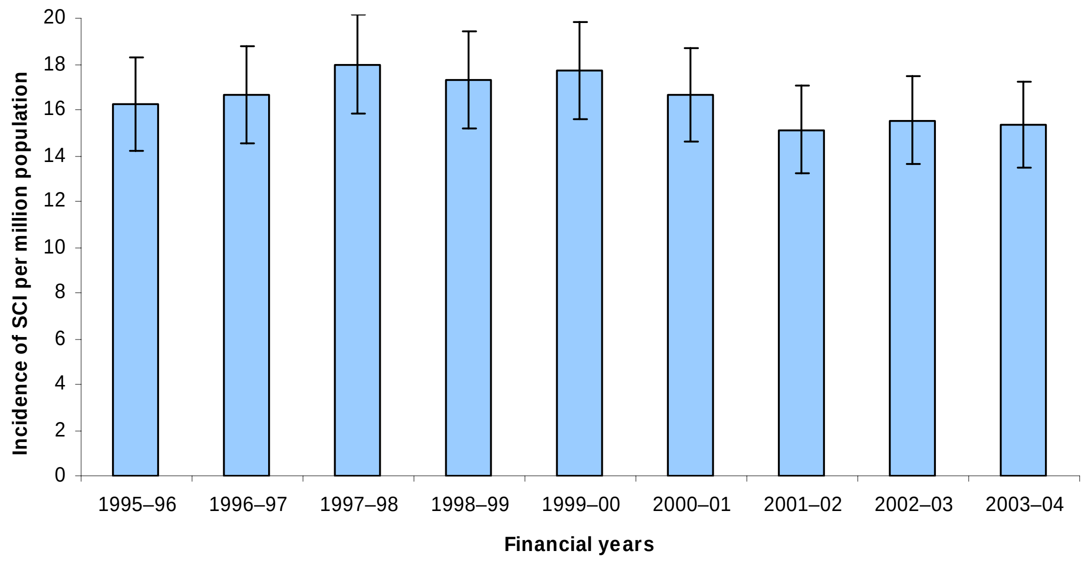
This section of the report describes the incidence of persisting SCI in 2003–04, including trends and the incidence of SCI by state and territory of usual residence, socio-demographic characteristics of the traumatic cases and factors associated with the SCI event.

Given the rarity, at present, of neurological recovery from SCI, cases discharged during financial year 2003–04 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 will be discussed in Section 6 of this report, the 'Clinical information' section. These cases are an important group to monitor because they contribute to the prevalent SCI population whose health and welfare requires ongoing care and, commonly, financial support. The size of the persisting SCI group reflects the combined effects of the rate of incidence of SCI, the patient response to retrieval and treatment, and the rate of survival to discharge. Two hundred and forty-seven Australian residents who sustained SCI from traumatic causes during 2003–04 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 2003–04 in the Australian population aged 15 years and older was estimated to be 15.3 new cases per million population aged 15 years and older (Figure 3.1). The rate was lower than the rate in 2002–03 (15.5 new cases per million population), but not significantly different (95% CI=13.4–17.3).

One paediatric case (cases under the age of 15 years) was excluded from this calculation, as done in previous years, due to the poor coverage of this group in the Register. Children with SCI are usually treated in paediatric hospitals rather than SUs.



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 (246 cases) in 2003–04.

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

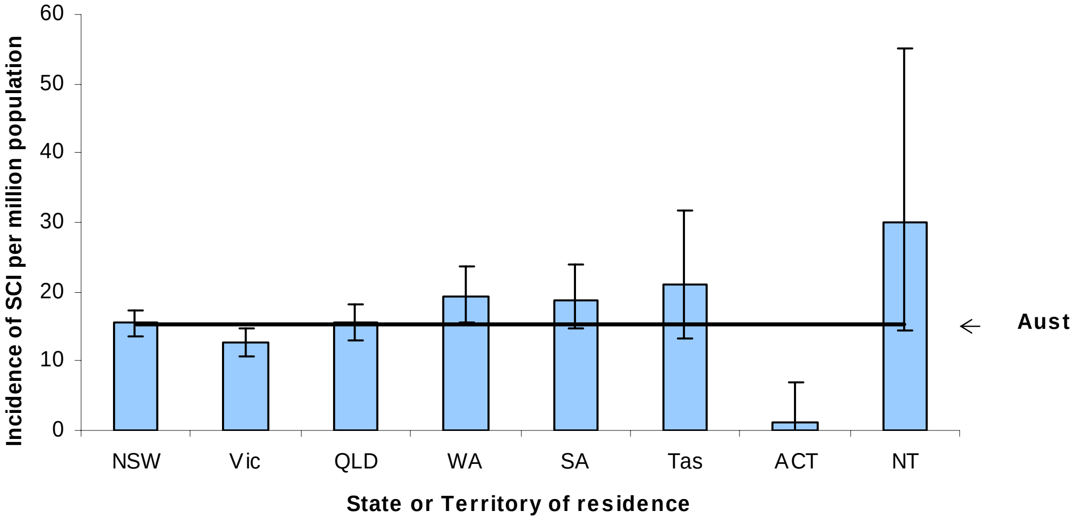
The age adjusted rate of incidence of persisting SCI from traumatic causes by state and territory of usual residence is presented in Figure 3.2. Due to the small number of cases in some jurisdictions, incidence rates for jurisdictions are annual average rates based on cases in the three years 2001–02 to 2003–04. (This differs from calculations in previous reports.)

Three-year case counts for Tasmania (23 cases), the Australian Capital Territory and the Northern Territory (11 cases combined) were low which was reflected in the confidence intervals for these three jurisdictions.

The incidence rates range from a high of 29.9 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

Only residents of the Australian Capital Territory had a three-year annual average rate of incident persisting SCI that differed significantly from the national incidence rate (1.2 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 2001–04 (three-year annual average rates, age 15 years and over)

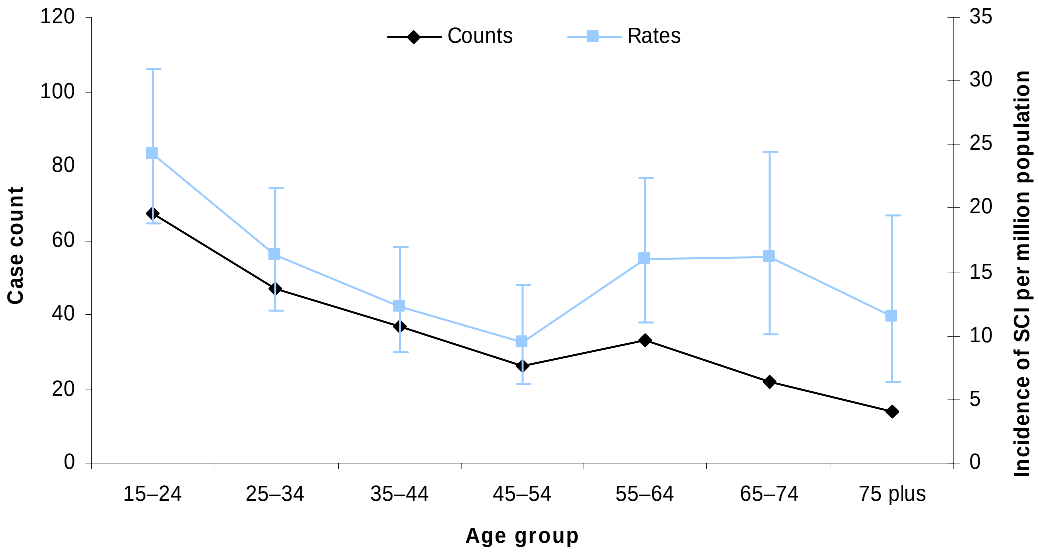
3.3 Age and sex distribution

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 27% (n=67) 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 55–64 years and declined thereafter. The pattern of counts and rates was less variable than those reported in 2002–03, but the pattern of age-specific rates was substantially similar. Rates for the 75 years and above age group were similar in both reporting periods.

The 95% confidence intervals on the rates, based on the Poisson distribution, indicated that in 2003–04, rates in the 15–24 year age group were significantly higher than rates in the 35–44 and 45–54 year age groups.

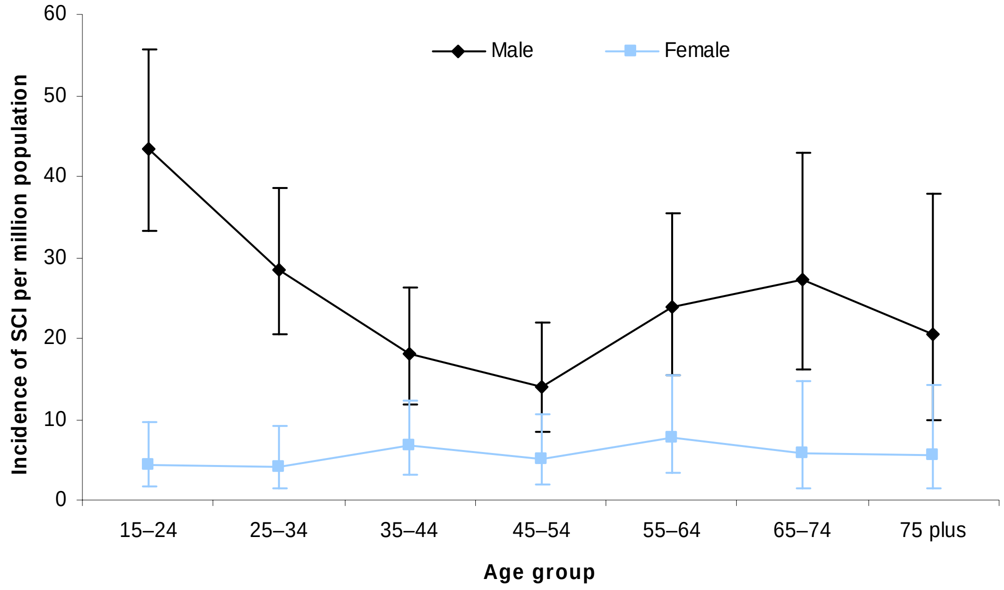
Of the cases of persisting SCI from traumatic causes, 82% were male and 18% were female.

Rates for males were higher than rates for females at all ages (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 2.7:1 in the age group 35–44 and 45–54 year age groups to a high of 9.7:1 in the age group 15–24 years. Case counts for persons aged 75 years and above, were low and accounted for about 7% of the new cases of persisting SCI from traumatic causes.



Note: Error bars indicate 95% confidence intervals for rates. One case under the age of 15 years was excluded.

Figure 3.3: Incidence of persisting SCI from traumatic causes by age group, Australia 2003–04 (counts and age-specific rates)



Note: Error bars indicate 95% confidence intervals for rates. One case aged less than 15 years was excluded.

Figure 3.4: Incidence of persisting SCI from traumatic causes by age group and sex, Australia 2003–04 (age-specific rates)

3.4 Marital status and unemployment

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, educational level attained and employment 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 and 3.2).

Almost half of the patients were married or in a de-facto relationship. More than one-third of the patients had never married. Most (65%) 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 13% of cases 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 per cent of the cases were employed when they acquired persisting SCI (Table 3.2). About one third of these people were working as a tradesperson, 30% were employed in professional or technical occupations, 9% were managers and the remaining 30% were either in clerical positions or labourers. Fifteen per cent had a tertiary or post graduate education, over 30% had a trade qualification or apprenticeship and about a third had completed secondary school.

The vocational potential of SCI cases in Australia is quite good with about 40% of persons with SCI returning to work (Athanasou 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 2003–04 (counts and column percentages)

	Age of the person with SCI at the time of admission							
	0–24		25–64		65–75 plus		All ages	
Marital status	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Never married	61	90	31	22	*	*	92	37
Widowed	*	*	*	*	10	28	11	4
Divorced	*	*	12	8	*	*	14	6
Separated	*	*	6	4	*	*	8	3
Married (includes de facto)	6	9	90	63	23	64	119	48
Not stated	*	*	*	*	*	*	*	*
Group total	**68**	**100**	**143**	**100**	**36**	**100**	**247**	**100**

* Cell counts 3 or less 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 2003–04 (counts and column percentages)

	Age of the person with SCI at the time of admission							
	0–24		25–64		65–75 plus		All ages	
Employment status	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Employed	28	41	90	63	5	14	123	50
Pensioner	4	6	12	8	29	81	45	18
Unemployed/Not available for employment-school/other/missing	36	53	41	29	2	6	79	32
Group total	**68**	**100**	**143**	**100**	**36**	**100**	**247**	**100**

4 Factors associated with the SCI event

In addition to collecting information on the incidence of SCI, including socio-demographic features of the cases, the ASCIR also collects information about the event resulting in injury, such as mechanism of injury, role of human intent, type of place of injury, and type of activity at the time of injury. Such factors are often referred to as *External Causes of Injury*. This information, coded according to the NISU's National Data Standards for Injury Surveillance (NDS-IS), provides information to improve understanding of the underlying events that led to the injury. Such information is intended to assist in setting priorities for prevention, and in the development and implementation of injury prevention interventions to decrease the incidence of SCI in Australia.

4.1 External cause of injury

The main external causes of injury for cases of persisting SCI from traumatic causes are tabulated in Table 4.1. SCI cases tabulated in Table 4.1, originally coded to NDS-IS, have been allocated to external cause categories that reflect major causes of SCI. These cases could also be assigned to more than one category and where appropriate are discussed in the following sections. External causes of injury by age group are presented in Figures 4.1–4.3. Cases are described by external cause and neurological level of injury in Table 4.2. The external causes shown in Table 4.1 are described in the following sections.

Table 4.1: Incidence of persisting SCI from traumatic causes by external cause of injury (major groupings); Australia 2003–04 (counts and column percentages)

External cause	Counts	Per cent
Land transport: Motor vehicle occupants	58	23
Land transport: Unprotected road users (motor cyclists, pedal cyclists, pedestrians)	44	18
Low falls (on the same level, or from a height of < 1 metre)	26	11
High falls (from a height of 1 metre or more)	57	23
Water related (diving in pools or ocean, surfing)	24	10
Sports related	16	6
Other causes (e.g. crushed, hit by objects, assaults, self-inflicted injury)	22	9
All external causes	**247**	**100**

4.1.1 Motor vehicle occupants

Motor vehicle occupant cases were a little more likely to be young (ages 0–34 years) than all traumatic persisting SCI cases and a little less likely to be middle aged (35–44 years; 33% vs 39%) (Figure 4.1).

Most of the motor vehicle accidents occurred during leisure activities (n=30, 52%) or travelling to or from work, or from other work related activities (n=13, 22%).

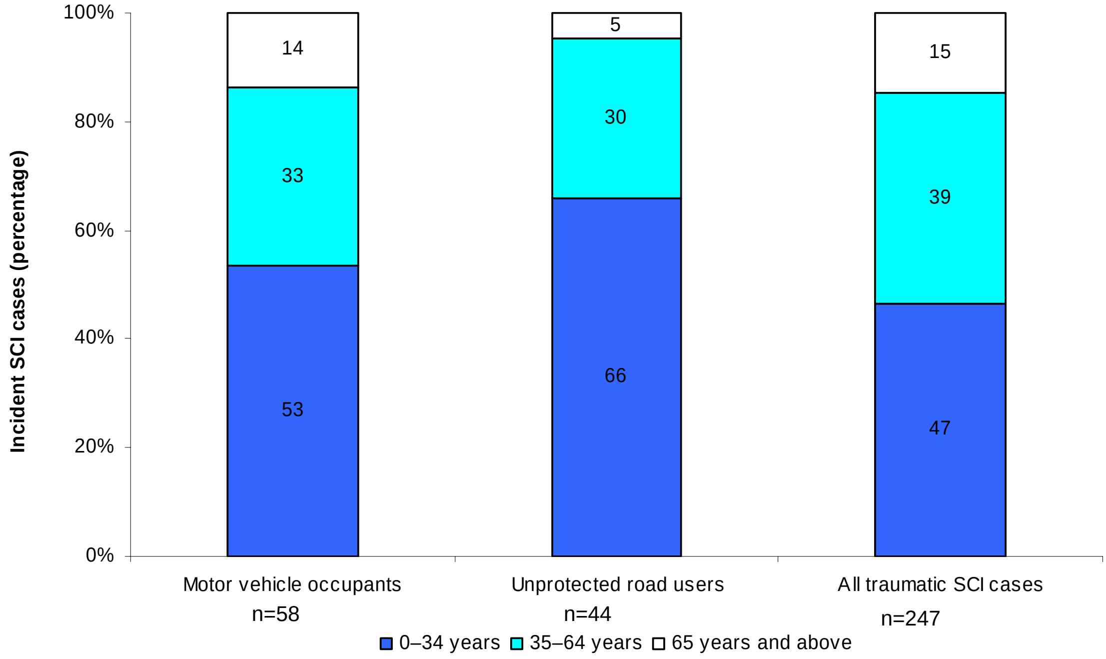


Figure 4.1: Incidence of persisting SCI from motor vehicle and unprotected road user accidents by age group, Australia 2003–04 (percentages of each group)

Additional information relevant to reducing SCI for motor vehicle occupants was obtained from the structured injury narrative. The main cause of motor vehicle occupant persisting SCI was vehicle rollover, accounting for 48% (n=28) of the cases (3% more than the equivalent proportion [45%] reported in 2002–03). High speed appears to be a major contributing factor for accidents involving rollover with almost a half of the narratives indicating vehicles were travelling at speeds about 100kph or more. Ejection of occupant occurred in 12% (n=7) of the rollover cases and impact with another vehicle or roadside hazard occurred in 18% (n=5) of the other rollovers.

For non-rollover motor vehicle occupants, impact with another vehicle was reported in about 21% (n=12) of the motor vehicle accidents and 22% (n=13) involved an impact with roadside hazards such as poles or trees.

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=36) of the cases in the *Motor vehicle occupants* group sustained injuries to the cervical spinal segments resulting in tetraplegia (Table 4.2). Nearly one-quarter of these cases (n=8) had complete injury at the cervical level. Head injuries, including loss of consciousness, were also reported in 37% (n=17) 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), abdomen (e.g. liver and spleen lacerations) and various fractures to upper and lower limbs.

In cases involving rollover (n=28), 71% (n=20) of the occupants had injury to the cervical segments of the cord resulting in tetraplegia. Twenty per cent (n=6) of these cases resulted in complete tetraplegia. The remaining rollover cases (n=8) had injury to the thoracic and lumbar spinal segments resulting in paraplegia and 50% of these cases (n=4) had complete injury to the cord resulting in complete paraplegia.

Table 4.2: Incidence of persisting SCI from traumatic causes by external cause (major groupings), and neurological level of injury at admission; Australia, 2003–04 (counts and row percentages)

	Tetraplegia		Paraplegia									
	Cervical		Thoracic		Lumbar		Sacral		All paraplegia		Total	
External cause	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Land transport: Motor vehicle occupants	36	62	16	28	5	9	1	2	22	38	58	100
Land Transport: Unprotected road users (motor cyclists, pedal cyclists, pedestrians)	17	39	19	43	8	18	0	0	27	61	44	100
Low falls (on the same level, or from a height of < 1 metre)	20	77	4	15	1	4	1	4	6	23	26	100
High falls (from a height of 1 metre or more)	20	35	18	32	16	28	3	5	37	65	57	100
Water related (diving in pools or ocean, surfing)	23	96	0	0	1	4	0	0	1	4	24	100
Sports related	10	63	2	13	4	25	0	0	6	38	16	100
Other causes	9	41	5	23	8	36	0	0	13	59	22	100
All causes	**135**	**55**	**64**	**26**	**43**	**17**	**5**	**2**	**112**	**45**	**247**	**100**

4.1.2 Unprotected road users

Unprotected road users are users of land transport without the protection of a structure such as a car body. They include motor cyclists, bicyclists and pedestrians and account for 18% (n=44) of all cases of persisting SCI during 2003–04 (about 5% lower than the equivalent proportion [23%] reported in 2002–03) (Table 4.1). Sixty-six per cent (n=29) of these cases were in the age group 0–34 years compared with 47% (n=115) of all traumatic SCI cases. Only 5% (n=2) of unprotected road user cases incident in 2003–04 were at ages 65 years or older (Figure 4.1).

Eighty per cent (n=35) of the unprotected road user cases of persisting SCI in 2003–04 were motor cyclists (drivers or pillion passengers), 11% (n=5) were pedal cyclists and 9% (n=4) were pedestrians. Motorcyclists in the 15–34 year age group (n=26) represented 74% of motorcycle cases at all ages and 23% of all persisting SCI cases in this age group. Unprotected road user cases over the age of 54 years (n=9) were primarily pedal cyclists and pedestrians.

Fifty-two per cent of the unprotected road users (n=23) were injured during leisure, 18% (n=8) during sporting activities and 16% while travelling to or from work (n=7). The remaining unprotected road users (n=6) were injured during other/unspecified activity.

The neurological level of injury in unprotected road users was cervical in 39% of the cases (n=17), and thoracic or lumbar in the remainder, resulting in a higher proportion of paraplegia (61%, n=27) than tetraplegia (Table 4.2). This is similar to neurological levels reported in 2002–03, where paraplegia accounted for 63% (n=35) of the cases.

Forty-three per cent of 2003–04 cases of persisting SCI among unprotected road users (n=19) acquired complete injury of the spinal cord (46% for motor cyclist cases).

4.1.3 Falls

Falls, both low (less than 1 metre or on the same level) and high (from 1 metre or higher) accounted for 34% (n=83) of persisting SCI cases during the 2003–04 reporting period (Table 4.1).

Although low falls were less frequent than high falls in 2003–04 overall (26 cases versus 57 cases), they were more common than high falls at ages greater than 65 years (Figure 4.2). Fifty-eight per cent of low falls (n=15) occurred at home while doing housework and other personal activities. Alcohol intoxication was reported in 5 low fall cases.

Slipping or tripping occurred in about one-third of low fall cases at ages 65 years 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 R & Carman J 2001).

Low falls resulted in tetraplegia in 76% of cases (n=20) due to injury to the cervical spinal segments (Table 4.2). Paraplegia was less common (n=6) and involved injury to thoracic, lumbar and sacral spinal segments. Among cases at ages 65 years and older, tetraplegia occurred in 77% (n=10) with extent of injury to the cervical segments of the cord being incomplete in all but one of the cases.

Sixty-nine per cent (n=57) of the injurious falls were from a height of 1 metre or higher. Eighty-eight per cent of cases due to falling from a height were at ages 15–64 years, compared with 50% of low falls (Figure 4.2).

Forty-two per cent (n=24) of high falls occurred while at work (construction site or factory) and 23% (n=13) involved work, but not for income, such as doing handyman jobs around the home (using a ladder, on a roof, or cutting tree branches). Eighty-three per cent of the people who fell during 'handyman' types of activities were aged 54 years and above. Eleven per cent of cases involving high falls (n=6) were due to attempted suicide, with 5 of the attempts occurring in the 15–24 year age group. Leisure activities such as horse riding and hiking accounted for 12% (n=7) of the cases.

Falling from a height resulted in paraplegia in 65% of the cases (n=37) and in tetraplegia in the remaining cases (Table 4.2). In the paraplegic cases, injury to the thoracic spinal segments was more common than injury to lower spinal segments. Fifty-four per cent (n=31) of the cases from high falls had an incomplete lesion of the cord.

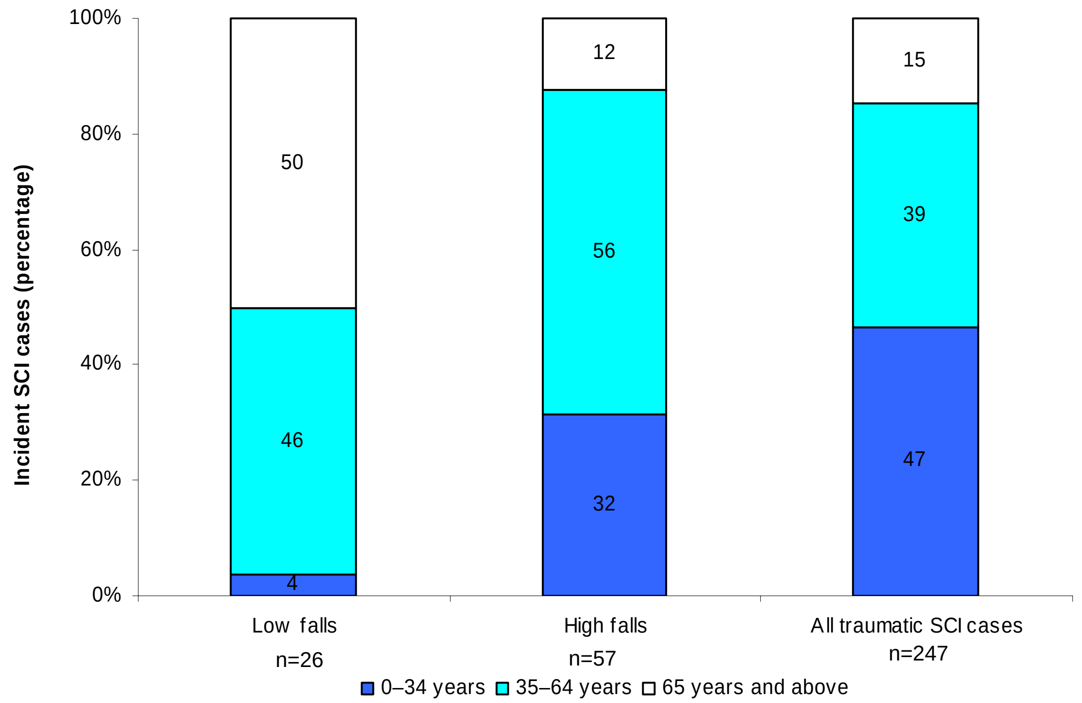


Figure 4.2: Incidence of persisting SCI from low and high falls by age group, Australia 2003–04 (percentages of each group)

4.1.4 Water related

Water related events accounted for 10% (n=24) of the persisting SCI cases reported during 2003–04 (Table 4.1) and 71% (n=17) of these occurred at ages under 35 years (Figure 4.3).

Ninety six per cent (n=23) of water related SCI reported had injury to the cervical spinal segments (Table 4.2), with 25% sustaining complete injury to the cord after diving into bodies of water without being aware of the depth.

Twenty-nine per cent of the injuries (n=7) were related to surfing, 17% occurred in swimming pools and 38% were the result of diving into bodies of shallow water.

4.1.5 Sports related

Sports related injury resulted in 6% (n=16) of the persisting SCI cases reported during 2003–04 (Table 4.1) and 63% of the cases (n=10) had injury to the cervical spinal segments (Table 4.2). Sports injuries occurred primarily in age groups 15–34 years (Figure 4.3).

All cases of injury from contact sports occurred during rugby (n=6) and resulted in injury to the cervical spinal segments. The persisting SCI occurred during a group tackle in 5 of the 6 cases. No players were under the age of 19 years and a third of the cases resulted in complete lesion of the cervical spinal cord.

The remaining sports related cases reported (n=10) occurred during skiing, horse riding, cycling, rock climbing and paragliding. Injuries sustained by skiers, horse riders and cyclists (n=4) resulted in tetraplegia and injuries to paragliders and rock climbers resulted in paraplegia due to injury to the thoracic and lumbar spinal segments. The horse riders, cyclists and rock climbers had complete lesion of the spinal cord.

The grouping of external causes shown in Table 4.1 results in some cases that might be regarded as sport-related being placed in other categories. Of cases of persisting SCI in 2003–04, there are 7 cases that occurred while surfing and 8 cases that occurred during motor cycle racing. Addition of these 15 cases that occurred during sport or active recreations to the 16 already in the sports-related category results in a total of 31 persisting SCI cases.

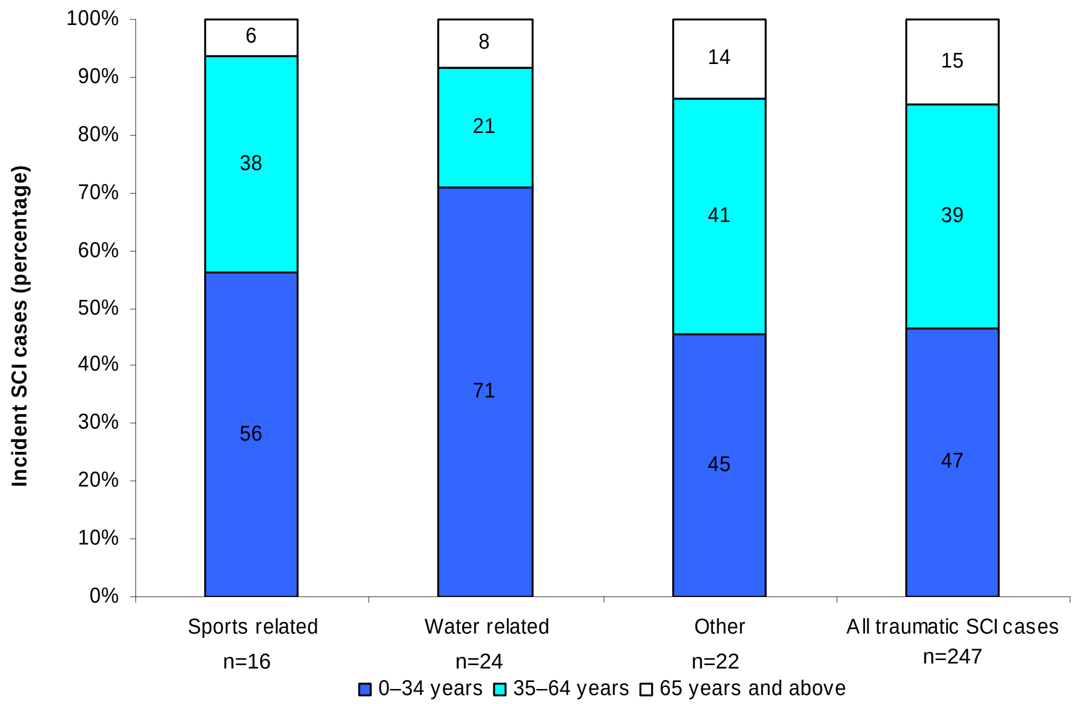


Figure 4.3: Incidence of persisting SCI from water related, sports and other accidents by age group, Australia 2003–04 (percentages of each group)

4.1.6 Other causes

Nine per cent of the SCI cases (n=22) reported during 2003–04 had an external cause of injury that was not included in the other major groups of external causes in Table 4.1. These injuries occurred over a broad range of ages primarily in the age group 0–64 years (Figure 4.3).

Cases that had an external cause of injury reported, sustained injury to their spinal cord from crushing or being hit by an object (4 cases), and assault (gunshot and stabbing/cutting (6 cases). Seven cases of persisting SCI in this group occurred while working for income. Mechanisms of these cases included injury by crushing or being hit, injury from lifting heavy objects and electrocution. The remaining cases in this group had an SCI as a result of complications of surgical or medical care, suicide attempt, and self-inflicted injury.

Forty-one per cent of persisting SCI cases in the *Other causes* grouping sustained injury to the cervical spinal segments which resulted in incomplete tetraplegia in all of these cases. Injury to the thoracic and lumbar spinal segments resulted in paraplegia in 59% of the cases in this group (Table 4.2). Eighty per cent of the injured thoracic spinal segments had complete lesion of the cord and all lumbar spinal segments were incomplete.

5 Trends in external causes of persisting SCI

Annual rates of persisting SCI in Australia, overall, have not shown marked trends during the period of operation of ASCIR (Figure 3.1). With the availability of 9 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 the period 1986–1997, largely using data collected before ASCIR commenced (O'Connor 2002). The focus of this section is overall trends in total persisting SCI and trends in the 2 most common external causes of SCI in Australia, motor vehicle crashes and falls. Selection of persisting SCI cases for trend analysis was made on ASCIR records coded to the NDS-IS. Methods employed for analysis of trends are described in Appendix 1.

5.1 Trends in persisting SCI

Incidence of SCI due to traumatic causes is presented in Figure 5.1 for persons aged 15 years and above, 15–34 years and 55 years and above for the period 1995–96 to 2003–04. These 3 age groups were chosen to provide estimated incident SCI rates for all ages (15 years and above), and for a younger and older sub-group.

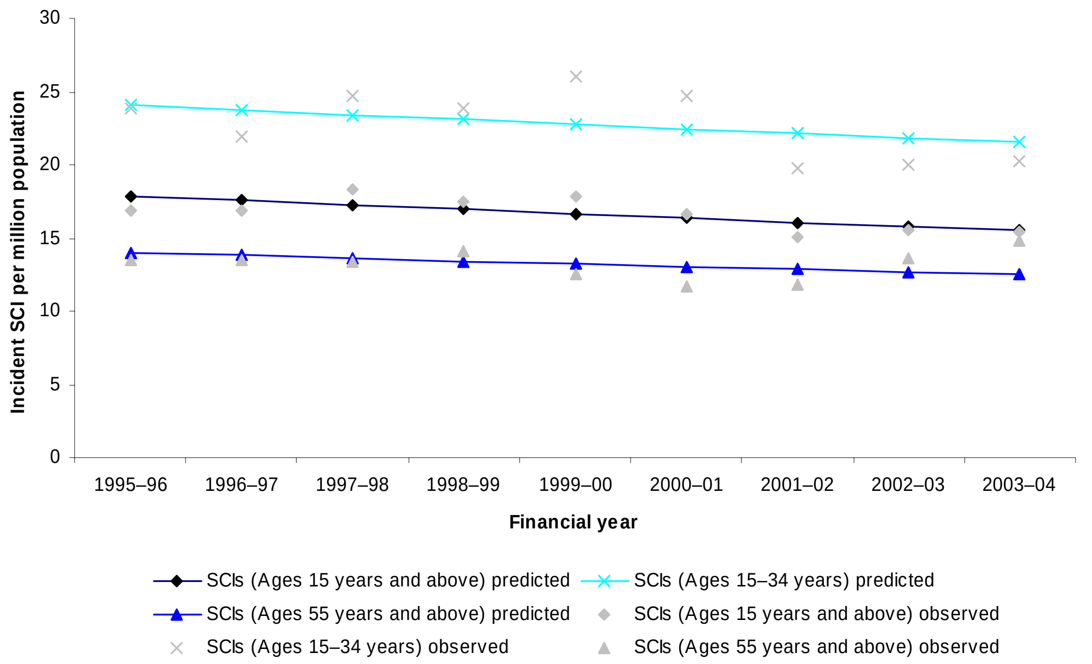


Figure 5.1: Incidence of SCI from traumatic causes by financial year; Australia (ages 15 years and above; 15–34 years and 55 years and above)

The 1995–96 estimated incident SCI rate for ages 15 years and over was 17.9 cases per million population (95% CI 16.6–19.3). The rate at the beginning of the period for age-group 15–34 years was significantly higher* than the rate for ages 15 years and over (24.1 cases per million population; 95% CI 22.1–26.3) and the rate for age group 55 years and older (14.0 cases per million population; 95% CI 12.6–15.7).

Estimates from the regression modelling (Poisson) indicate a declining trend for all 3 of the age groups considered. The average annual decline was 1.7% for age group 15 years and above, 1.4% for ages 15–34 years and 1.4% for ages 55 years and above.

5.2 Motor vehicle crashes

Each year, a large proportion (over 50%) of incident SCI admissions to spinal units is caused by road traffic accidents and falls. In this section, trends in motor vehicle accidents and falls (low and high) will be examined.

Incidence of SCI due to motor vehicle accidents is presented in Figure 5.2 for persons aged 15 years and above. The goodness-of-fit test for the Poisson model indicated the presence of overdispersion (i.e. variation in SCI counts was significantly more than would be expected from a Poisson distributed variable). Hence, Negative Binomial Distribution regression was used, resulting in higher p-values and wider confidence intervals in the trend analysis of these data (see Data issues, p.35).

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

Estimates obtained from the regression modelling (Negative Binomial) indicate a significant decline in the incidence rate of SCI from motor vehicle accidents during the period 1995–96 to 2003–04.

The 1995–96 estimated incident SCI rate for ages 15 years and above was 7.9 cases per million population (95% CI 6.8–9.2). According to the fitted model, this estimated annual age-specific rate declined by 2.9% per year during the period 1995–96 to 2003–04.

During ASCIR's period of operation, motor cyclists have accounted for about one-third of all cases of SCI due to motor vehicle crashes. Being unprotected road users put these riders and pillion passengers at greater risk of severe injury than occupants of cars.

Estimates obtained from the regression modelling (Poisson) indicate a significant increase in the incidence rate of SCI from motor cycle accidents during the period 1995–96 to 2003–04. The estimated incident SCI rate at the beginning of this period for ages 15 years and above was 1.7 cases per million population (95% CI 1.4–2.2). According to the fitted model, this 1995–96 estimated annual age-specific rate in motor cycle accidents increased by 4.1% per year during the 1995–96 to 2003–04 reporting period.

The effect of the motor-cyclist sub-group on overall trends of motor vehicle related SCI can be seen by considering motor vehicle cases other than motor cyclists. For motor vehicle accident cases, excluding motor cyclists, the 1995–96 estimate incident SCI rate for ages 15 years and above was 6.3 cases per million population (95% CI 5.2–7.7) and decreased at a higher rate (5.3%) per year than the rate of SCI for all motor vehicle accidents during the period 1995–96 to 2003–04.

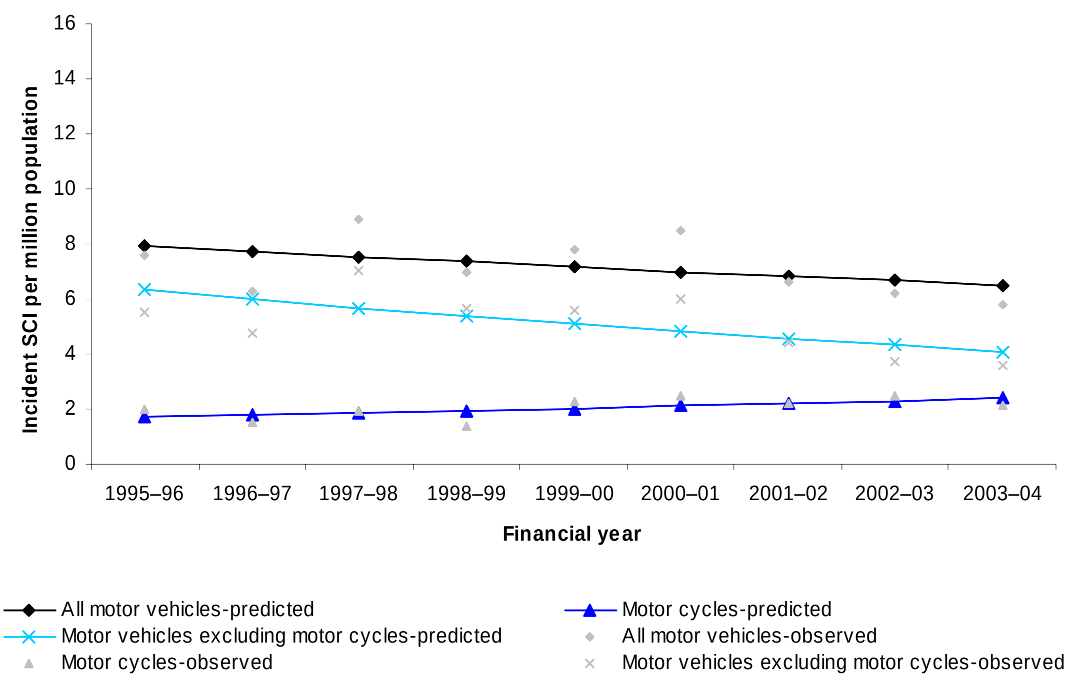


Figure 5.2: Incidence of SCI from motor vehicle accidents by financial year; Australia (ages 15 years and above)

An examination of motor vehicle accident data for the 15–34 year age group (a high risk group) indicated the estimated incident SCI rate during 1995–96 was not only higher than the rate for ages 15 years and above (12.4 cases per million, 95% CI 10.6–14.6) but the rate was also declining at a lower rate (1.6% versus 2.9%) over the period (Figure 5.3), indicating this age group remained at higher risk of SCI than the 15 years and above age group during the 1995–96 to 2003–04 period.

Considering motor cycle accident data for the 15–34 year age group, the 1995–96 estimated incident SCI rate was higher initially (3.3 cases per million, 95% CI 2.5–4.1) than the 15 years and above age group and increased at a rate of 5.0%, higher than the rate of increase for the 15 years and above age group over the same period (4.1%).

This increase in motor cycle related SCI cases is of particular concern because over one-third of cases in 2003–04 had complete lesion of the spinal cord which is likely to affect their level of independence post rehabilitation and contribute to a greater health burden in terms of service needs and medical care for this group living with SCI.

The impact of motorcyclist cases on total motor-vehicle related SCI is particularly strong for the age group 15–34 years. Considering motor vehicle cases other than motor cyclists, the estimated incident SCI rate for the initial year of the 1995–96 to 2003–04 period was higher initially than the rate for the 15 years and above age group (9.3 cases per million, 95% CI 7.7–11.3) but the rate declined at a lower rate (4.5% versus 5.3%) over the same period. The decrease in this motor vehicle related group of SCI cases may be reflecting the national trend in decreasing motor vehicle deaths and hospitalisations since the 1970s (Federal Office of Road Safety 1998; Kreisfeld et al. 2004).

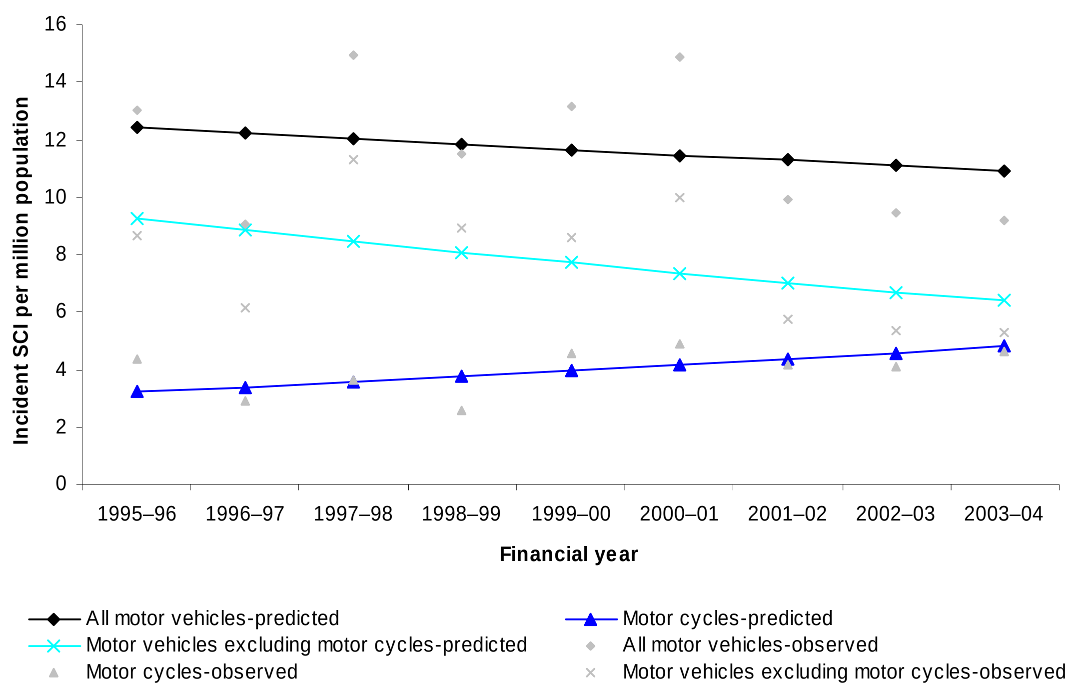


Figure 5.3: Incidence of SCI from motor vehicle accidents by financial year; Australia (ages 15–34 years)

5.3 SCI due to falls

Falls from a height ('high falls') and falls occurring more or less on the same level ('low falls') are a major cause of SCI, responsible for about one-third of incident SCI admissions each year. Incidence of SCI from falls for ages 15 years and above is presented in Figure 5.4 for the period 1995–96 to 2003–04.

Estimates obtained from regression modelling indicate a statistically significant decrease in the incidence rate of SCI from all falls and high falls in the all ages group 15 years and above. The 1995–96 estimate incident SCI rate for all falls was 5.9 cases per million population (95% CI 5.2–6.8) which declined at a rate of 1.6% per year and a estimate incident SCI rate for the same period for high falls of 4.1 (95% CI 3.5–4.8), declining at a rate of 3.5%, over twice the rate for all falls.

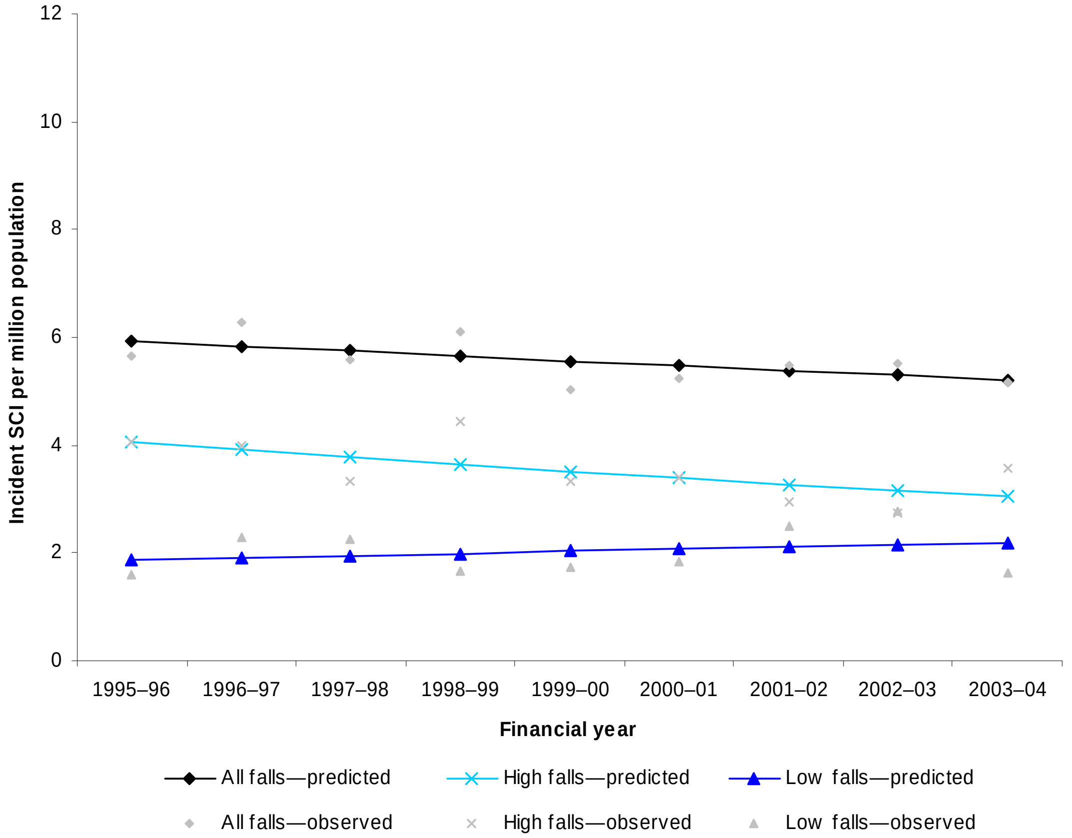


Figure 5.4: Incidence of SCI from falls (high and low falls) by financial year; Australia (ages 15 years and above)

For low falls, the 1995–96 estimated incident SCI rate was about half the rate of high falls (1.9 (95% CI 1.5–2.4), but the rate increased by 1.9% per year rather than decreased. Over 9 financial years, the modelled increase in SCI from low falls in the age group 15 years and above was 17.9%.

As part of the ageing process, muscle strength, coordination and reflexes decline and health conditions such as cardiovascular disease can affect daily activities and put people at risk of SCI from falling and declining bone strength makes serious fractures a more likely outcome of falling. Incidence of SCI from falls for ages 55 years and above is presented in Figure 5.5.

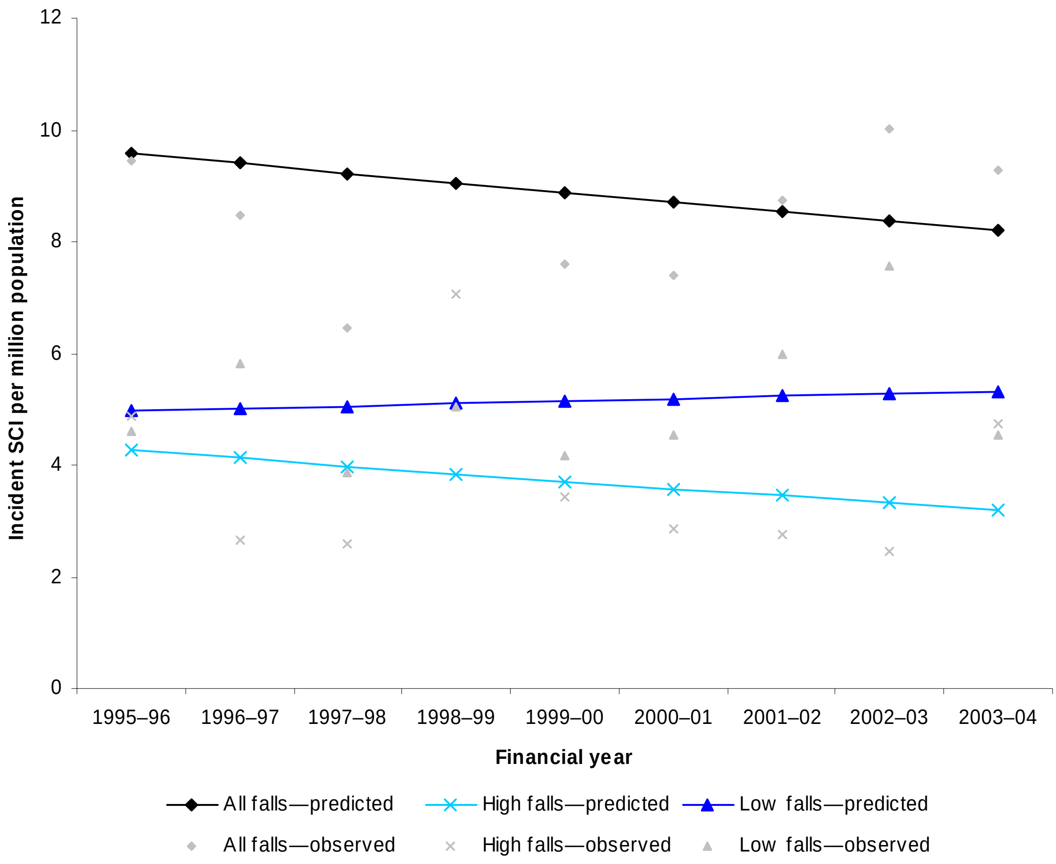


Figure 5.5: Incidence of SCI from all falls (high and low falls) by financial year; Australia (ages 55 years and above)

Estimates obtained from the regression modelling indicate higher incident SCI rates during the first year of the 1995–96 to 2003–04 period for all falls (9.6 [95% CI 8.2–11.2]) incident SCI per million population versus 5.9 (95% [CI 5.2–6.8])) and low falls (5.0 [95% CI 3.9–6.3] incident SCI per million population versus 1.9 (95% [CI 1.5–2.4])) for the age group 55 years and above. Incident SCI rates for high falls were similar in both age groups.

Incident SCI rates for all falls and high falls for age group 55 years and above declined at similar rates to the 15 years and above age group. Although the incident SCI rate for low falls increased more slowly than the 15 years and above age group (0.9% versus 1.9%), the 1995–96 incident SCI rate for age group 55 years and above was over two and a half times higher than the 15 years and above age group rate. Over 9 financial years the modelled increase in SCI from low falls was about 8%.

Injury related to low falls tends to rise sharply at older ages. For age group 75 years and above, the estimated incident SCI rate for low falls for the same period was higher (7.7 cases per million population (95% CI 6.1–11.0)) than the estimated rate for the age group 55 years and above (5.0 cases per million population (95% CI 3.9–6.3)), but was not significantly higher, reflecting small case numbers.

This increase in rates in an ageing population highlights the importance of fall prevention programs targeted to the elderly to reduce the risk of falling.

In 2003–04, the great majority of the cases of persistent SCI from low falls in the oldest age group resulted in incomplete tetraplegia. Treatment and rehabilitation for this level of cord injury is compounded by other co-morbidities associated with ageing. Successful outcomes from rehabilitation are likely to be quite low in this cohort.

Problems of providing carers, appropriate housing and other support services may not be as readily available for the elderly as for younger SCI groups where some support is provided by family (i.e. parents). The health burden would also be high, managing complications of tetraplegia and other health problems in this age group.

6 Clinical characteristic of persisting SCI cases

The monitoring of clinical information on SCI enables the patients' outcomes in response to treatment to be studied and provides, indirectly, 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 degree of impairment is routinely reported by SUs during the acute admission and at discharge from rehabilitation.

In previous reports, discussion of clinical features of SCI focused on neurological injury that was reported at acute admission. In this report the discussion is based on *persisting* SCI cases, i.e. cases who had their incident SCI injury in 2003–04 from traumatic causes, have an ASIA score A to D either 90 days post injury or at discharge from rehabilitation (end of episode of care) and occurred in Australia or overseas to Australian residents. During 2003–04, 247 SCI cases admitted to SUs met this definition. Of the 247 cases, 3 cases were still on ward, one case was a paediatric case and discharge dates of 4 cases were not reported at the time of writing this report. Two hundred and forty-seven 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 215 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.

6.1 Neurological level of injury

The neurological level of SCI at discharge is presented in Figure 6.1. The most commonly reported neurological injury was to the cervical segments (55%, n=135) and to the spinal segments at the thoraco-lumbar junction (T12 and L1, 10%, n=25).

Sixty-six per cent of the 135 cases (n=89) 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 financial year 2002–03 (67%, n=96). During the 2003–04 reporting period, a similar proportion of cases had neurological loss below the C4 cervical level as was seen during 2002–03 (20% versus 22%).

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-five per cent (n=135) had an injury at the cervical level. This type of impairment is referred to as *tetraplegia*.

Forty-five per cent (n=112) 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=50), C5 (16%, n=39), and C6 (8%, n=20) and the lumbar segment with loss below L1 (6%, n=16).

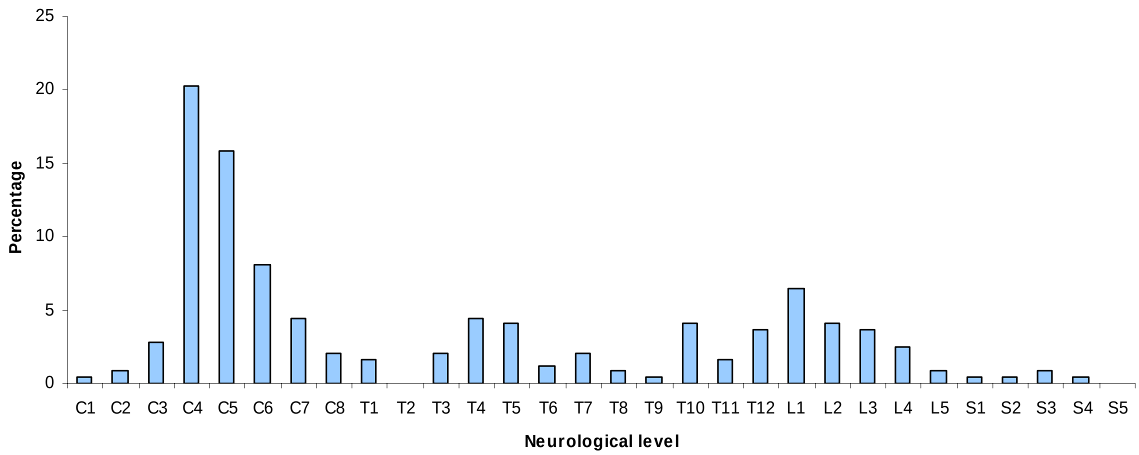


Figure 6.1: Incidence of persisting SCI from traumatic causes by neurological level at discharge; Australia 2003–04 (percentages)

6.2 Neurologic 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 neurologic categories (complete tetraplegia, incomplete tetraplegia, complete paraplegia, incomplete paraplegia, and complete recovery). Table 6.1 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 (247 cases), the most common neurologic category was incomplete tetraplegia (41%, n=101), followed by incomplete paraplegia (23%, n=57), complete paraplegia (17%, n=43) and complete tetraplegia (14%, n=25). 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 A & Panjabi M 1990)

Table 6.1: Incidence of persisting SCI from traumatic causes by neurological level (major grouping) and extent of injury; Australia 2003–04 (counts and table percentages)

Extent of injury	Tetraplegia		Paraplegia								Total	
	Cervical		Thoracic		Lumbar		Sacral		All paraplegia			
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Complete	34	25	44	69	4	9	0	0	48	43	82	33
Incomplete	101	75	20	31	39	91	5	100	64	57	165	67
Total	**135**	**100**	**64**	**100**	**43**	**100**	**5**	**100**	**112**	**100**	**247**	**100**

6.3 Duration of initial care

During financial year 2003–04, 215 cases with persisting SCI from traumatic causes were discharged from SUs after completing rehabilitation. Patients who were discharged to another hospital to complete their rehabilitation (n=25) were not included in this section. 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 a 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 neurologic category, is presented in Table 6.2.

The average duration of initial care (ADIC) for all cases of SCI discharged (215 cases) was 136 days (about four and a-half months), ranging from a high of 261 days (about eight and a-half months) for cases of complete tetraplegia to 51 days for a case of incomplete paraplegia involving injury to sacral spinal segments.

Table 6.2: Neurological status of injury to the spinal cord of persisting cases of SCI from traumatic causes for age groups discharged during 2003–04 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	26	261	39	156	3	169	0		42	157	68	197
Incomplete	88	116	19	127	36	86	4	51	59	97	147	108
Total	**114**	**149**	**58**	**146**	**39**	**92**	**4**	**51**	**101**	**122**	**215**	**136**

In general, cases with tetraplegia had an ADIC 22% greater than cases with paraplegia (149 days, S.D.=119, versus 122 days, S.D.=76). For cases with paraplegia, the longest ADIC was reported for cases with injury to the thoracic spinal segments (extent of injury cases combined). The ADIC for cases 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 (39 cases versus 3 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 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 neurologic category is presented in Figure 6.2.

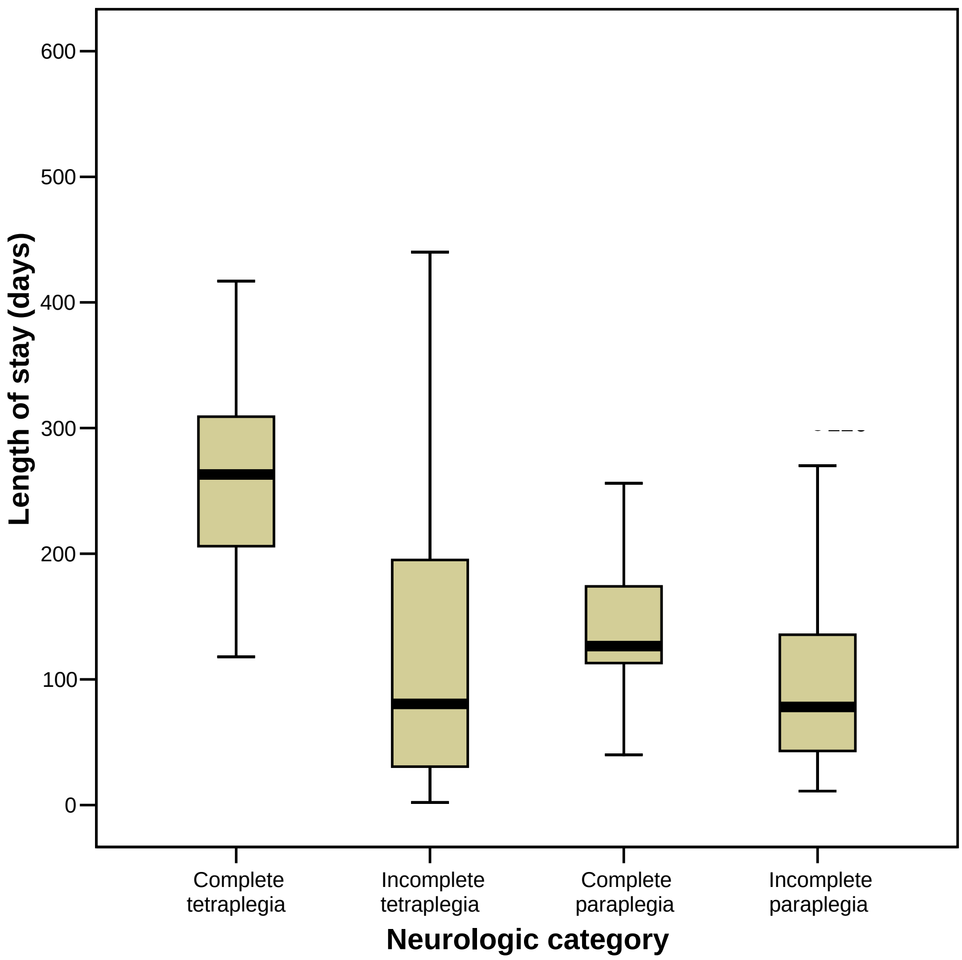


Figure 6.2: Distribution of length of stay by neurologic category at discharge, Australia 2003–04 (median and percentiles)

All neurologic categories except complete tetraplegia show a positive skew with the medians below the 50 percentile (if normal distribution was occurring, the median would be in the middle of the box between the 25th and 75th percentiles) and the 95th percentile extended. The neurologic category complete tetraplegia has one outlier below the 5th percentile, incomplete tetraplegia and incomplete paraplegia have one outlier greater than the 95th and complete paraplegia has 4 outliers greater than the 95th percentile.

An examination of these outliers indicated a mid level cervical injury occurred in the case with complete tetraplegia. For the other outliers which had prolonged length of stay (positive skew), head, chest and pelvic injuries occurred that would prolong the normal length of stay for these spinal cases.

Cases with complete tetraplegia and complete paraplegia had the highest median length of stay (263 and 127 days, respectively).

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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 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 this reporting period (i.e. in 2002–03).

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, secondary 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 motor cycle riders.