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Venomous bites and stings in Australia to 2005

Clare Bradley

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Executive summary

This report describes the bites and stings due to contact with venomous animals and plants that resulted in a separation from an Australian hospital in the period 1st July 2002 to 30th June 2005. Analyses of bite and sting cases over time (1999–05) are also presented.

We estimate that there were 11,602 cases of venomous bites and stings that resulted in hospitalisation in the 2002–05 period, with the average annual number of cases being 3,867 (an age-standardised rate of 19.4 cases per 100,000 population).

One-third (33.5%) of cases in the three-year period were spider bites, most frequently attributed to redback spiders. Bee stings accounted for nearly one-quarter (23.7%) of hospitalised cases in 2002–05 and 15.1% of cases were attributed to venomous snakes.

Bites and stings attributed to venomous animals and plants were more common for males and for younger people. Males accounted for 63.3% of all hospitalised bite or sting cases in the 2002–05 period and these occurred at a rate of 24.5 per 100,000 population (compared to a rate of 14.2 per 100,000 population for females). The mean age of a person admitted to hospital due to a venomous bite or sting was 34.5 years.

Types of venomous bite and sting cases 2002–05

Snakes

Despite Australia's notoriety as habitat for some of the world's most dangerous snakes, as noted above, only 15.1% of hospitalised bite and sting cases during the 2002–05 study period were attributed to contact with venomous snakes (1,750 cases, 2.9 cases per 100,000 population). About half (53.5%) of the cases attributed to venomous snakes in 2002–05 involved snakes of the brown snake immunotype. Bites attributed to black and tiger snakes were also relatively frequent (14.6% and 11.4% respectively).

Over the three-year study period, a further 1,394 cases were identified with a principal diagnosis of W59.1 (bitten or crushed by a snake, unknown whether venomous or non-venomous)—a similar number of cases to those attributed to venomous snakes.

Spiders

Contact with spiders was the most common external cause type for hospitalised bite and sting cases in 2002–05 (3,887 cases, 33.5% of all bite and sting cases, 6.5 cases per 100,000 population). Unlike many other types of venomous bites and stings, males and females were hospitalised for spider bites in a relatively equal proportion; 54.5% of the cases involved males.

Most spider bite cases (58.6%, 2,277 cases) were attributed to the redback spider and only a small proportion of spider bite cases (2.9%) were attributed to the notorious Sydney funnel web spider and related funnel web spiders.

Wasps and bees

Contact with hornets, wasps and bees was the second most common type of bite and sting case in the 2002–05 study period (3,557 cases, 30.7%). Bee stings accounted for 77.4%of such cases, and most of these cases involved males (73.1%). Despite the greatest bee-related threat to Australians being stings from honey bees, most cases in 2004–05 (the only year for which such coding was available) were attributed to contact with unspecified bees (93.5%).

Wasps were responsible for 22.3% of hospitalised cases attributed to hornets, wasps and bees and, as for bee stings, most wasp stings involved males (62.3%). Surprisingly few hospitalised wasp stings (2.9%) in 2004–05, when such coding was available, were attributed to yellow jacket wasps (e.g. the European wasp). Most hospitalised wasp sting cases in 2004–05 were attributed to unspecified wasps (81.3%).

Ants and ticks

Bites and stings from 'other venomous arthropods', primarily ants and ticks, accounted for 9.7% of hospitalised cases in the 2002–05 study period. Contact with venomous ticks was the principal external cause for 43.2% of these cases while contact with venomous ants accounted for 30.8%.

Most hospitalised ant stings were attributed to jack jumper (or hopper) and bulldog ants (60.8% in the year this coding was available) and no hospitalisations were explicitly attributed to the introduced fire ant.

Venomous marine animals and plants

Hospitalised bites and stings attributed to venomous marine animals and plants accounted for 9.0% of cases in the 2002–05 study period. Males had a considerably higher rate of marine bites and stings (2.5 per 100,000 population) than females (1.0 per 100,000) and age-specific rates were strongly skewed towards younger people.

One-third of marine bite and sting cases involved contact with venomous jellyfish (36.0%). Stonefish and other stinging fish were responsible for 18.3%, and contact with stingrays was also frequently reported (16.5%).

Other and unspecified venomous animals and plants

Other hospitalisations due to venomous bites and stings were variously attributed to scorpions, centipedes and venomous millipedes, and other or unspecified venomous animals and plants. Specified venomous plants caused the hospitalisation of 23 people over the three years, and there were two cases involving a sting by a platypus.

Factors associated with bite and sting cases 2002–05

Nearly a quarter of hospitalised venomous bites and stings occurred in the home (23.9%) and the home was the most common *specified* place of occurrence for all types of cases except marine bites and stings. However, more than half of all venomous bite and sting cases recorded an 'unspecified place' (56.1%). Similarly, nearly two-thirds of hospitalised bite and sting cases were coded to 'unspecified activity' (64.2%) in the 2002–05 study period. The frequent use of these imprecise categories gives little insight into the circumstances of the majority of hospitalised bites and stings and limits the development of prevention initiatives.

Analyses of bite and sting cases according to the person's state of usual residence were largely as expected, reflecting the known distributions of the venomous species in question and/or the expected level of exposure to these creatures. Overall, relatively high rates of hospitalised bite and sting cases were observed for residents of the Northern Territory, South Australia, Queensland and Western Australia. Lower rates were observed for residents of the Australian Capital Territory and Victoria. However, these patterns differed markedly depending on the type of bite or sting. For example, high rates of ant and tick bites and stings were observed for residents of Tasmania, likely due to the high level of sensitivity to jack-jumper ant venom in this population.

Rates of venomous bites and stings increased almost linearly according to the remoteness of the person's place of usual residence. Residents of major cities had the lowest rate of serious bites and stings (10.7 per 100,000 population) while the highest rate was observed for residents of the very remote regions of Australia (73.6 per 100,000 population).

Only 16.1% of records for hospitalised bite and sting cases in the 2002–05 study period listed any health intervention (procedure) codes. That is, it appears that 83.9% of bite and sting cases did not have any procedure conducted during the episode of care, although the majority of bite and sting cases had a principal diagnosis stating that the patient was suffering toxic effects of contact with venomous animals. Only 7.5% of hospitalised bite and sting cases listed a procedure block describing 'injection or infusion of therapeutic or prophylactic substance' or 'pharmacotherapy'.

Trends in hospitalised bites and stings 1999–05

We found the rates of hospitalisations due to venomous, or potentially venomous, bites and stings to be fairly stable over the six-year period to 30th June 2005. This was true for bite and sting cases overall and for particular types of bites and stings.

The noteworthy exception was the marked increase in marine-related bites and stings observed for residents of Queensland in 2001–02. Rates of marine stings for this population were much higher in this year than either the year preceding or following, confirming reports that the 2001–02 stinger season was particularly severe.

Changes made to the ICD-10-AM from 1st July 2002 improved the specificity of bite and sting data by introducing an unambiguous category for coding bites from snakes of unknown toxicity (W59.1), among other refinements. This change complicated assessment of time trends however; rates of venomous bites and stings *and* cases coded to W95.1 needed to be assessed together to avoid the spurious impression of a decline in incidence from 2002–03.

1 Introduction

A large number of Australians sustain bites and stings each year (ABS 2003; ABS 2006a). Frequently, such incidents involve non-venomous animals such as dogs, cats or horses (Ozanne-Smith et al. 2001; Kreisfeld & Harrison 2005; MacBean et al. 2007). Nevertheless, the Australian fauna and flora contains a wide diversity of venomous creatures which are found in both terrestrial and marine ecosystems. Australian venomous species include elapid snakes, spiders, jellyfish and insects, all of which are capable of inflicting fatal bites and stings if inappropriately managed (Sutherland 1983). Fortunately, deaths due to contact with venomous animals and plants are rare (Winkel et al. 1998). Nonetheless, many bites and stings due to contact with venomous species result in admission to hospital each year in Australia.

This report describes the bites and stings due to contact with venomous animals and plants which resulted in a separation from an Australian hospital in the period 1st July 2002 to 30th June 2005. These records were coded to the third and fourth editions of the Australian Modification of the International Classification of Diseases (ICD-10-AM). In these editions, the relevant coding categories were expanded to provide significantly greater detail of the case than has been available previously (see NCCH 2002; NCCH 2004).

Hospital separations data were extracted from the National Hospital Morbidity Database (NHMD). Separations that met the following criteria were selected for analysis in the first instance:

- Records separating from hospital between 1st July 2002 and 30th June 2005, which also had;
- A first-listed (leftmost) external cause code in the range X20–X29.

Due to inter-hospital transfers and re-admissions, which cannot be demarcated in the de-identified data, the number of records meeting these criteria over-estimates the actual number of bite and sting events that resulted in serious injury and illness. To address this, records stating a mode of admission of 'transfer from another acute hospital' were omitted to estimate incidence.

The end-date of the study period, 30th June 2005, completes a six-year series of national hospital data coded to various editions of the ICD-10-AM. As such, analysis has also been undertaken here for bite and sting cases separating from an Australian hospital between 1st July 1999 and 30th June 2005, in order to ascertain the longitudinal trends associated with these types of cases. For these analyses, incidents (cases) were defined in the same way as outlined above (external cause X20–X29, mode of admission other than transfer to another acute hospital), however as the earlier editions of the ICD-10-AM do not contain the resolution of the later editions, analyses have been restricted to the basic (three-character) ICD-10-AM codes.

1.1 Venomous bites and stings 2002–05

A total of 12,042 hospital separations were identified as having a first external cause in the range X20–X29 in the period 1st July 2002 and 30th June 2005 (Table 1). These separations accounted for 0.5% of the 2.3 million hospital separations primarily attributed to external causes in the study period. Of the total number of hospital separations coded to X20–X29 in 2002–05, 11,602 separations had a mode of admission other than 'transfer from another acute hospital' and were considered to represent the incidence (events, cases) of serious bites and stings. The following analyses concern these incident separations. The remaining 440 separations were considered to be second and/or subsequent separations associated with the incident cases which, if included, would over-estimate the incidence of bite and sting events that resulted in hospitalisation. Accordingly, these transfer separations have been excluded from the following analyses.

Table 1: Hospital separations with a first external cause code in the range X20–X29, Australia 2002–05

Mode of admission	2002–03	2003–04	2004–05	Total 2002–05
Admitted patient transferred from another hospital	136	167	137	440
Statistical admission—type change	*	*	*	*
Other	3,894	3,877	3,822	11,593
Unknown/not provided	*	*	*	*
Total	**4,032**	**4,049**	**3,961**	**12,042**
Incident cases due to bites and stings	*3,896*	*3,882*	*3,824*	*11,602*

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

Shading denotes modes of admission included in case estimation.

The average annual number of venomous bite and sting cases that resulted in hospitalisation in the period 1st July 2002 and 30th June 2005 was 3,867.3 per year. The age-standardised rate of hospitalised bite and sting cases for the three-year study period was 19.4 per 100,000 population.

1.1.1 Age and sex distribution

Bites and stings attributed to venomous animals and plants were more common for males and for younger people. Males accounted for 63.3% of all hospitalised bite or sting cases in the period 2002–05 (n=7,343). Accordingly, the age-standardised rate of hospitalised bite and sting cases was higher for males (24.5 per 100,000 population) than for females (14.2 per 100,000 population), a rate ratio of 1.7 bite and sting cases for males for every incident involving females.

The mean age of a person admitted to hospital due to a bite or sting incident was 34.5 years (± 20.4 SD). A third of all hospitalised bites and stings in 2002–05 were for people aged younger than 25 years (34.8%, n=4,032). Only 2.9% of cases involved people aged 75 years or older (n=333). The mean age of males separating from hospital due to a bite and sting incident in the period 2002–05 was slightly younger (33.8 years ± 19.8 SD) than the mean age for females (35.8 years ± 21.3 SD).

Age-specific rates of bites and stings were significantly higher for males than for females until the age of 75 years and older (Figure 1). Nevertheless, the pattern of rates for males and females was quite similar; with high rates observed for younger people and a general decreasing trend in the rates of hospitalised bites and stings at older ages. A peak in rates of bite and sting cases were observed for children aged 5–14 years, more so for males than for females. A second distinct peak was observed in the rate of bites and stings for males aged 30–34 years. For this age group, the rate of hospitalised bite and sting cases in males was twice that for females (M:F ratio=2.0).

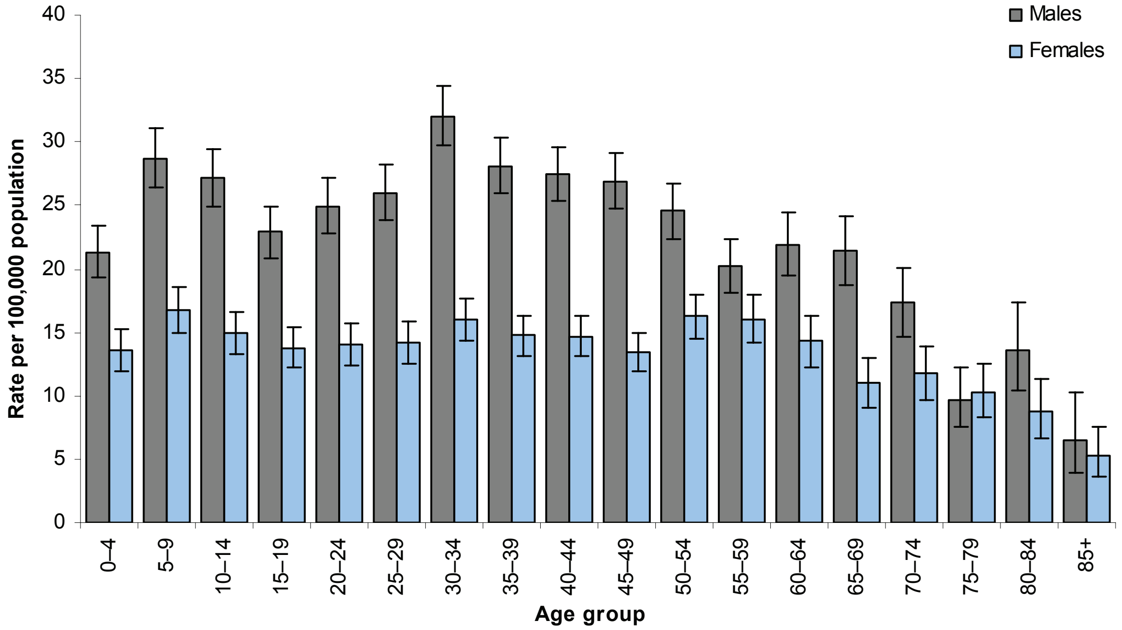


Figure 1: Age-specific rates (± 95% CI) for hospitalised bite and sting cases (X20–X29): males and females, Australia 2002–05

1.1.2 Cases by state of usual residence

Analysis of bite and sting cases attributed to venomous animals and plants was undertaken according to the state of usual residence of the hospitalised person. It must be taken into account that such analyses may not accurately reflect the circumstances of the incident in that the person may have been bitten or stung outside of their state of usual residence (e.g. while on holiday). Further, state of usual residence is not recorded for international visitors. Nonetheless, given the availability of population data at state-level, this method is the best measure of the distribution of serious bite and sting cases across the nation.

The age-standardised rates of hospitalised bite and sting cases for the period 2002–05 significantly differed according to the state or territory of usual residence. The highest rate observed was 36.3 cases per 100,000 population for males resident in South Australia (Figure 2). This rate was closely matched by that for males resident in the Northern Territory (36.0 per 100,000). Rates for males resident in Queensland and Western Australia were also high. The lowest age-standardised rate of hospitalised bite and sting cases for males was observed for residents of the Australian Capital Territory (8.6 per 100,000), and this rate was significantly lower than the rates observed for males resident in all other states of Australia.

The age-standardised rate of hospitalised bite and sting cases was considerably lower for females than that for males in each state or territory. Nonetheless, the pattern observed for females was similar to that for males; rates were highest for females resident in the Northern Territory (25.7 per 100,000) and lowest for females resident in the ACT (3.9 per 100,000).

It is important to note that, in general, higher rates were observed for states and territories with warmer climates, conditions which contribute to a higher incidence of venomous fauna and flora and residents' exposure to these species (e.g. Taylor et al. 2002; Macrokanis et al. 2004).

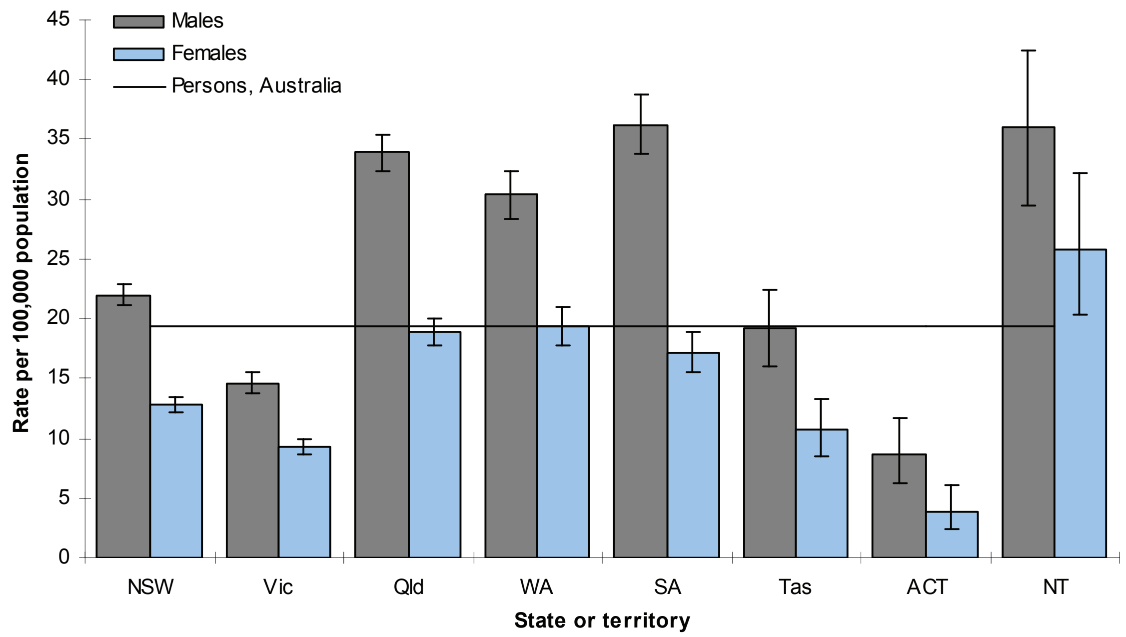


Figure 2: Age-standardised rates (± 95% CI) for hospitalised bite and sting cases (X20–X29), state or territory of usual residence: males and females, 2002–05

1.1.3 Cases by remoteness of usual residence

Analysis of rates of venomous bite and sting cases for the period 2002–05 was also undertaken according to the remoteness classification of the person's place of usual residence. For reasons similar to those outlined for state-based analyses, it must be remembered that analyses according to a person's remoteness of usual residence may not accurately describe the place in which the incident occurred for some cases.

The rate of bite and sting cases involving venomous animals and plants that required hospitalisation in the period 2002–05 increased almost linearly according to the remoteness of the person's place of usual residence. Residents of the major cities of Australia had the lowest rate of serious bites and stings (persons: 10.7 cases per 100,000 population) while the highest rate was observed for residents of the very remote regions of Australia (73.6 cases per 100,000 population). The age-standardised rates of hospitalised bite and sting cases were significantly higher for males than for females in each remoteness zone (Figure 3). The rates of bites and stings showed the same increasing trend for both genders and the width of the confidence intervals suggest that each increase in rate with increasing remoteness is significant, except between the remote and very remote areas of Australia.

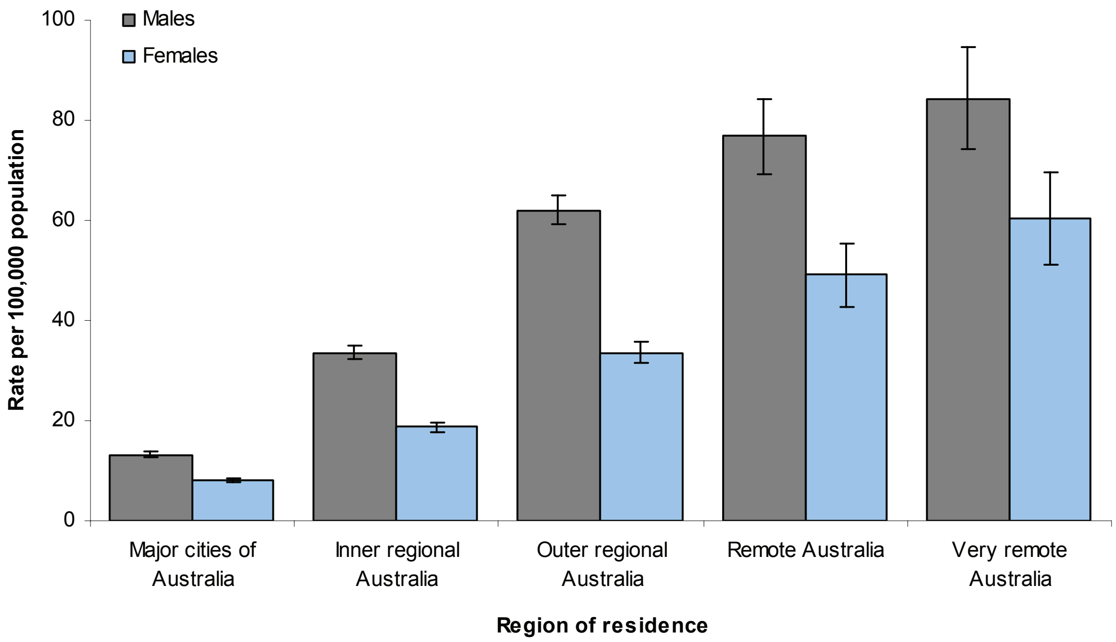


Figure 3: Age-standardised rates (± 95% CI) for hospitalised bite and sting cases (X20–X29), remoteness of usual residence: males and females, 2002–05

1.1.4 Types of bite and sting cases

The most common external cause attributed to venomous bite and sting cases between 1st July 2002 and 30th June 2005 was X21, contact with spiders (Table 2). A third of all hospitalised bite and sting cases involved spiders (33.5%, n=3,887), a similar proportion being observed in each of the three years of the study period. Similarly, X23, contact with hornets, wasps and bees, was the second most common type of bite and sting for incident cases in each year of the study period. Three in ten incident cases were attributed to hornet, wasp or bee stings during 2002–05 (30.7%, n=3,557).

Despite Australia's notoriety as habitat for some of the world's most dangerous snakes (Sutherland 1992a; Shaw & Leggat 2003), only 15.1% of hospitalised bite and sting cases during the 2002–05 study period were coded with X20, contact with venomous snakes and lizards, as the first external cause (n=1,751). One in ten hospitalised bite and sting cases nationally (9.0%, n=1,041) were attributed to venomous marine animals and plants—a considerable proportion given that many of these species, including the deadly box jellyfish (*Chironex fleckeri*), are confined to northern coastal waters (Underhill 1995). Other venomous arthropods (X25), primarily venomous ants and ticks, were also responsible for one in ten bite and sting cases during the period of analysis (9.7%, n=1,127).

For most types of venomous bites and stings, particularly the most numerous categories, males were involved in a far higher proportion of cases than females, as described by the male:female ratio in Table 2.

Table 2: Type of bite and sting (first external cause) for hospitalised cases, Australia 2002–05

External cause	Cases	Per cent	M:F ratio
Contact with venomous snakes and lizards (X20)	1,751	15.1%	2.1
Contact with spiders (X21)	3,887	33.5%	1.2
Contact with scorpions (X22)	24	0.2%	0.8
Contact with hornets, wasps and bees (X23)	3,557	30.7%	2.4
Contact with centipedes and venomous millipedes (tropical) (X24)	31	0.3%	0.9
Contact with other specified venomous arthropods (X25)	1,127	9.7%	1.3
Contact with venomous marine animals and plants (X26)	1,041	9.0%	2.6
Contact with other specified venomous animals (X27)	14	0.1%	3.7
Contact with other specified venomous plants (X28)	23	0.2%	1.3
Contact with unspecified venomous animal or plant (X29)	147	1.3%	1.7
Total (X20–X29)	**11,602**		**1.7**

1.1.5 Principal diagnosis for bite and sting cases

Most hospitalised venomous bite and sting cases between 1st July 2002 and 30th June 2005 were coded with a principal diagnosis T63—toxic effect of contact with venomous animals (Table 3). The subcategories included in the T63 code do not exactly match the coding of venomous bite and sting external causes (e.g. some X20 cases had a principal diagnosis of T63.3, venom of spider, while some X21 cases had a principal diagnosis of T63.0, snake venom). Nonetheless, the proportions coded to specific subcategories of T63 correlated with the proportions designated to similar external causes. For example, a high proportion of cases had a principal diagnosis code T63.4 (venom of other arthropods, 28.2%) and stings from wasps, bees, ants and ticks were very common external causes for hospitalised incident cases. Likewise, a quarter of all bite and sting cases were coded to a T63.3 principal diagnosis (venom of spiders), spider bites being the most common external cause for incident cases.

Nearly three in ten venomous bite and sting incident cases were coded with a principal diagnosis other than T63 (28.0%, n=3,252). Half of these cases (50.9%, n=1,656) had a principal diagnosis from elsewhere in Chapter XIX of the ICD-10-AM (injury, poisoning and certain other consequences of external causes). Many of these injuries (38.9%, n=645) had a principal diagnosis of T78 (adverse effects, not elsewhere classified), a code which describes allergic and anaphylactic reactions. Other common principal diagnoses from Chapter XIX were S91 (open wound of the ankle or foot: 15.9%, n=263) and S61 (open wound of the wrist and hand: 12.0%, n=198). The frequent use of these wound codes for bite and sting incident cases was expected, and suggest that clinically significant envenomation did not occur as a result of the contact with the venomous creature.

The other half of incident cases not coded with a principal diagnosis of T63 were coded to the non-injury chapters of the ICD-10-AM (n=1,596). As anticipated, most of these cases had a principal diagnosis from Chapter XII (diseases of the skin and subcutaneous tissue: 63.9%, n=1,020). Frequent principal diagnoses from this chapter assigned to venomous bite and sting incident cases described conditions such as cellulitis (L03, n=682) and urticaria (L50, n=135).

Table 3: Principal diagnosis for hospitalised bite and sting cases, Australia 2002–05

Principal diagnosis	Cases	Per cent	M:F ratio
Principal diagnosis is not T63	3,252	28.0%	1.8
Snake venom (T63.0)	1,341	11.6%	2.2
Venom of other reptiles (T63.1)	*	0.0%	*
Venom of scorpion (T63.2)	*	0.2%	*
Venom of spider (T63.3)	2,954	25.5%	1.2
Venom of other arthropods (T63.4)	3,276	28.2%	2.1
Toxic effect of contact with fish (T63.5)	81	0.7%	5.2
Toxic effect of contact with other marine animals (T63.6)	554	4.8%	1.8
Toxic effect of contact with other venomous animals (T63.8)	26	0.2%	1.2
Toxic effect of contact with unspecified venomous animal (T63.9)	99	0.9%	2.0
Total	**11,602**		**1.7**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

1.1.6 Procedures listed for bite and sting cases

Hospital separation records report the health interventions undertaken during the episode of care in two ways; as six-digit procedure codes and as four-digit block codes. Block codes summarise allied procedures and the number of blocks listed in a record should match the number of procedures listed in the record.

Only 16.1% (n=1,863) records for hospitalised bite and sting cases in the 2002–05 period listed at least one block (and therefore procedure) code. That is, it appears that 83.9% of bite and sting cases did not have any health intervention conducted during the episode of care. This is perplexing as the majority of bite and sting cases had a principal diagnosis explicitly stating that the patient was suffering toxic effects of contact with venomous animals (T63, described above), and it is assumed that in many cases this would require the administration of an anti-venom of some kind. Likewise, we assume that allergic or anaphylactic reactions to venomous bites and stings (cases with a principal diagnosis of T78) would require the administration of adrenaline or antihistamines or similar. Nevertheless, only 7.5% (n=865, see Table 4) of all hospitalised bite and sting cases had a first-occurring procedure block describing 'injection or infusion of therapeutic or prophylactic substance' (block 1885, ICD-10-AM 3rd edition) or 'pharmacotherapy' (block 1920, ICD-10-AM 4th edition). A further 0.2% of cases (n=27) had these codes listed elsewhere in the record (bringing the total to 7.7%, n=892). Three-quarters of records containing these block codes (73.2%, n=653) were cases of spider bite and only 15.1% (n=135) were cases involving snakes.

Table 4: The first-listed procedure block for venomous bite and sting cases by principal diagnosis category, Australia 2002–05

First-listed procedure block	Principal diagnosis is T63	Principal diagnosis is other S or T	Principal diagnosis is not injury or poisoning	All cases
Continuous ventilatory support	10 (0.1%)	* (0.2%)	* (0.1%)	14 (0.1%)
Venous catheterisation	* (0.1%)	* (0.1%)	10 (0.6%)	18 (0.2%)
Incision procedures on other musculoskeletal sites	* (0.0%)	15 (0.9%)	* (0.5%)	24 (0.2%)
Excision procedures on other musculoskeletal sites	18 (0.2%)	31 (1.9%)	24 (1.5%)	73 (0.6%)
Removal of foreign body from skin & subcutaneous tissue	20 (0.2%)	25 (1.5%)	0 (0.0%)	45 (0.4%)
Other application, insertion or removal procedures on skin & subcutaneous tissue	* (0.0%)	* (0.1%)	6 (0.4%)	11 (0.1%)
Removal of foreign body from skin & subcutaneous tissue with incision	* (0.1%)	57 (3.4%)	* (0.2%)	67 (0.6%)
Incision & drainage of skin & subcutaneous tissue	25 (0.3%)	18 (1.1%)	65 (4.1%)	108 (0.9%)
Other incision procedures on skin & subcutaneous tissue	* (0.1%)	7 (0.4%)	* (0.2%)	16 (0.1%)
Other debridement of skin & subcutaneous tissue	21 (0.3%)	28 (1.7%)	22 (1.4%)	71 (0.6%)
Prophylactic vaccination or inoculation against certain bacterial diseases	9 (0.1%)	* (0.1%)	* (0.0%)	10 (0.1%)
Injection or infusion of therapeutic or prophylactic substance (3rd edition code 1885)	523 (6.3%)	27 (1.6%)	34 (2.1%)	584 (5.0%)
Pharmacotherapy (4th edition code 1920)	267 (3.2%)	* (0.2%)	* (0.6%)	281 (2.4%)
Blocks 1885 + 1920	*790 (9.5%)*	** (1.9%)*	** (2.8%)*	*865 (7.5%)*
Hyperbaric oxygen therapy	7 (0.1%)	0 (0.0%)	33 (2.1%)	40 (0.3%)
Other therapeutic interventions	* (0.1%)	8 (0.5%)	* (0.1%)	14 (0.1%)
Generalised allied health interventions	78 (0.9%)	21 (1.3%)	93 (5.8%)	192 (1.7%)
Computerised tomography of brain	18 (0.2%)	* (0.2%)	* (0.4%)	27 (0.2%)
Other procedure or block (n<10)	102 (1.2%)	299 (18.1%)	112 (7.0%)	268 (2.3%)
No procedure or block listed	7,223 (86.5%)	1,351 (81.6%)	1,165 (73.0%)	9,739 (83.9%)
Total	**8,350**	**1,656**	**1,596**	**11,602**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

Shading denotes the three most common procedures for each diagnosis category.

While contact with venomous animals and plants does not necessarily result in envenomation and anti-venoms are not currently available for some types of bites and stings (Sutherland 1983; Williamson et al. 1996), the relatively small number of records containing any procedure/block coding is surprising. The Australian Coding Standards suggest that T63 diagnoses are to be used when envenomation is evident and that procedure code 92182-00 (ICD-10-AM 3rd edition, block 1885) or a code from block 1920 (ICD-10-AM 4th edition) be used where anti-venom has been administered (see NCCH 2002; NCCH 2004). The Coding Standards also describe a scenario of a confirmed brown snake bite for which there is no sign of envenomation and for which no anti-venom was administered and instruct that a diagnosis code of 'open wound' be used in such situations rather than T63.0 (see NCCH 2002; NCCH 2004).

Nonetheless, informal consultation with clinicians and clinical coders suggest that these directives are not always followed and that institutions may have their own particular standards regarding the coding of diagnoses or procedures for venomous bite and stings; T63 diagnoses may be assigned to bite and sting cases in the absence of toxicological effects if the bite is confirmed and requires monitoring, or the administration of anti-venom, as a non-surgical procedure, may not be coded by some institutions. Such practices appear to run contrary to the Australian Coding Standards and prevent our better understanding of the medical procedures involved in hospitalised bite and sting cases.

1.1.7 Place of occurrence for bite and sting cases

Recent revisions of the ICD-10-AM have greatly expanded the number of categories available to code place of occurrence (e.g. NCCH 2002). Nevertheless, more than half of all hospitalised venomous bite and sting cases recorded an 'unspecified place' (56.1%, n=6,511. Table 5). One in five venomous bites and stings occurred in the home (including the driveway to the home, 23.9%, n=2,776) and the home was a more common place of occurrence for females (29.6%) than for males (20.6%). Conversely, males sustained a higher proportion of serious bites and stings on farms than females (2.9% vs. 1.3% respectively). Similarly, males sustained a higher proportion of bites and stings in industrial and construction areas (1.1% vs. 0.2%).

Table 5: Place of occurrence for hospitalised bite and sting cases (X20–X29): males, females and persons, 2002–05

Place of occurrence	Males	Females	Persons
Home	1,516 (20.6%)	1,260 (29.6%)	2,776 (23.9%)
Residential institution	19 (0.3%)	8 (0.2%)	27 (0.2%)
School	69 (0.9%)	45 (1.1%)	114 (1.0%)
Health service area	21 (0.3%)	27 (0.6%)	48 (0.4%)
Other specified institution & public administrative area	* (0.2%)	* (0.0%)	15 (0.1%)
Sports & athletics area	57 (0.8%)	18 (0.4%)	75 (0.6%)
Street & highway	94 (1.3%)	24 (0.6%)	118 (1.0%)
Trade & service area	61 (0.8%)	21 (0.5%)	82 (0.7%)
Industrial & construction area	78 (1.1%)	8 (0.2%)	86 (0.7%)
Farm	210 (2.9%)	54 (1.3%)	264 (2.3%)
Other specified place of occurrence	1,011 (13.8%)	435 (10.2%)	1,446 (12.5%)
Unspecified place of occurrence	4,164 (56.7%)	2,347 (55.1%)	6,511 (56.1%)
Place not reported/not applicable	* (0.4%)	* (0.2%)	40 (0.3%)
Total	**7,343**	**4,259**	**11,602**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

1.1.8 Activity for bite and sting cases

Recent revisions of the ICD-10-AM have also greatly expanded the number of categories available to record the activity engaged in when bitten or stung. Nonetheless, and similar to place of occurrence coding, nearly two-thirds of hospitalised bite and sting cases were coded with ‘unspecified activity’ (64.2%, n=7,451. Table 6) in the 2002–05 period. ‘Other specified activity’ was the second most common activity code assigned to bite and sting cases (13.0%, n=1,506). The frequent use of these imprecise categories gives little insight into the circumstances of the majority of hospitalised bites and stings.

The most common *specific* activity code assigned to bite and sting cases was ‘while engaged in other types of work’ (6.5%, n=758). This category is used to describe activities such as housework, home maintenance, gardening and studying (NCCH 2002). As such, it is not surprising that a very high proportion of bites and stings sustained while engaged in other types of work occurred in the home (77.7%, n=589). A significant proportion of bite and sting cases were also sustained while working for income (5.6%, n=647). Being seriously bitten or stung while working for income was more common for males than for females (565 cases and 82 cases respectively). A third of these cases occurred while working for income in the agriculture, forestry and fishing industries (33.7%, n=218) and one in five bites and stings sustained while working for income occurred on a farm (persons: 19.3%, n=125).

While the recent revisions of ICD-10-AM activity coding referred to above included several categories to broadly describe the industry in which people were working for income at the time of their injury, the greatest number of revised activity codes concerned the sports and leisure categories. Currently, 23 three-character level codes are available to describe such activities and a further 237 sub-categories (fourth- and fifth-characters) can describe the sports activity more precisely (NCCH 2002). For example; U54 (individual water sports) → U54.1 (fishing) → U54.10 (rock fishing). Only 4.6% of hospitalised bite and sting cases (n=532) during 2002–05 were coded as having been sustained while engaged in sports. Of these, three-quarters (75.6%, n=402) of the cases were coded to activities centred on water (e.g. fishing, swimming and snorkelling) and, not surprisingly, many of these cases involved jellyfish and other marine animals and plants. These cases are discussed in more detail in a later section.

Table 6: Activity codes for hospitalised bite and sting cases (X20–X29): males, females and persons, 2002–05

Activity	Males	Females	Persons
While engaged in sports	384 (5.2%)	148 (3.5%)	532 (4.6%)
While engaged in leisure	183 (2.5%)	98 (2.3%)	281 (2.4%)
While working for income	565 (7.7%)	82 (1.9%)	647 (5.6%)
While engaged in other types of work	416 (5.7%)	342 (8.0%)	758 (6.5%)
While resting, sleeping, eating, etc.	184 (2.5%)	191 (4.5%)	375 (3.2%)
Other specified activity	943 (12.8%)	563 (13.2%)	1,506 (13.0%)
Unspecified activity	4,636 (63.1%)	2,815 (66.1%)	7,451 (64.2%)
Activity not reported/not applicable	32 (0.4%)	20 (0.5%)	52 (0.4%)
Total	**7,343**	**4,259**	**11,602**

1.1.9 Length of stay for bite and sting cases

The length of stay for hospitalised venomous bite and sting cases was generally short. Nearly half of all bite and sting cases were discharged on the same day that they were admitted to hospital (45.9%, n=5,321). Including these cases, nine out of every ten cases had a length of stay of two days or less (91.0%, n=10,557) and less than one out of every hundred cases incurred a stay in hospital of more than a fortnight (0.5%, n=62).

The mean length of stay for all bite and sting cases was 1.5 days (± 2.8 SD). As described in Figure 4, the mean length of stay was similar for both males and females and remained consistent until the age of 35 years. While a slight increase in mean length of stay was observed for people aged 35 and older, large fluctuation in the mean length of stay was only apparent for people aged 70 years and older. The mean length of stay for males aged 85 years and older was particularly high (9.1 days ± 11.7 SD), however this was based on only 18 cases in the three year study period and the wide confidence intervals (standard error of the mean) reflect the variance in the data.

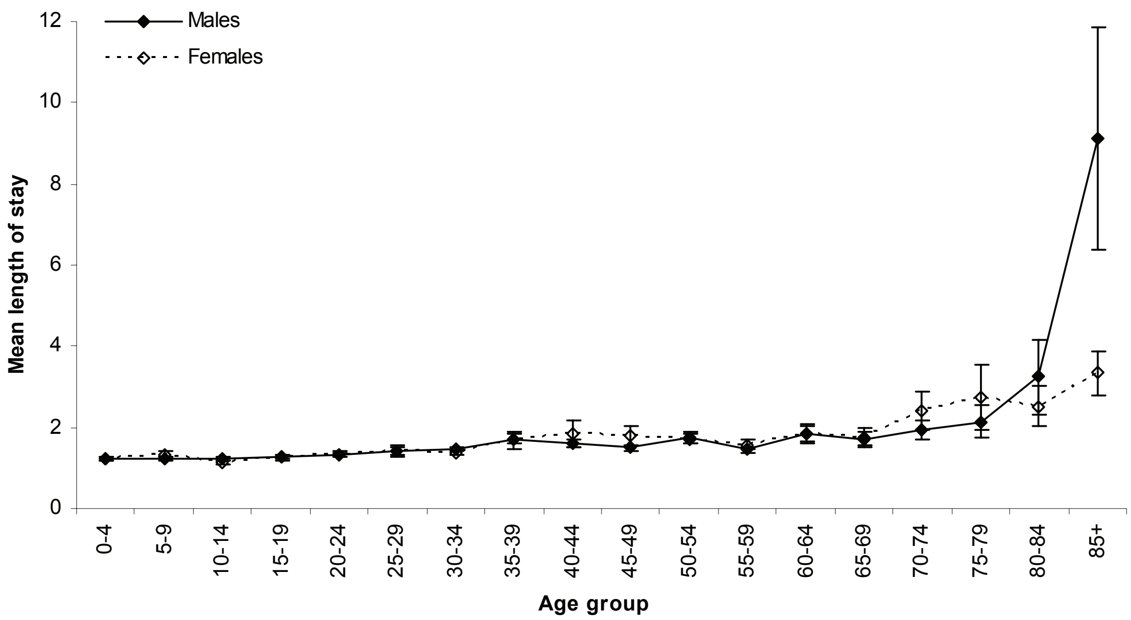


Figure 4: Mean length of stay (days ± SE) for hospitalised bite and sting cases (X20–X29): males and females, 2002–05

The 11,602 venomous bite and sting incident separations between 1st July 2002 and 30th June 2005 accounted for 17,888 days of hospitalised care and the inward transfer separations omitted for the main analysis contributed a further 1,290 days (Table 7). The annual average number of hospitalised bed-days attributed to venomous bites and stings for the period was 6392.7 days per year. These bed-days account for 0.1% of the total number of bed-days (15.9 million) primarily attributed to external causes in the three-year study period. The lower proportion of bed-days occupied relative to the proportion of estimated cases due to external causes results from the short lengths of stay frequently observed for these cases.

Table 7: Burden of hospitalised care due to contact with venomous animals and plants: bed-days occupied by separations attributed to X20–X29, Australia 2002–05

	Bed-days	2002–03	2003–04	2004–05	Total	Annual average
Males	Cases	3,638	3,702	3,763	11,103	3,701.0
	Transfers	308	265	248	821	273.7
	Total bed-days	*3,946*	*3,967*	*4,011*	*11,924*	*3,974.7*
Females	Cases	2,339	2,139	2,307	6,785	2,261.7
	Transfers	98	219	152	469	156.3
	Total bed-days	*2,437*	*2,358*	*2,459*	*7,254*	*2,418.0*
Persons	Cases	5,977	5,841	6,070	17,888	5,962.7
	Transfers	406	484	400	1,290	430.0
	Total bed-days	*6,383*	*6,325*	*6,470*	*19,178*	*6,392.7*

1.1.10 Mode of separation for incident cases

Nearly all people hospitalised due to venomous bites and stings were discharged to their place of usual residence (93.6%, n=10,857. Table 8).

Five hundred cases were transferred to another acute hospital (4.3%). Transfers to another acute hospital were most frequent for cases reporting contact with venomous snakes (X20, 52.8% of cases transferred. See Table 9). As expected, the mean ICISS severity score (probability of survival, see Stephenson et al. 2004) for transferred cases was significantly lower than for cases separating to their place of usual residence (transfers to another acute hospital, mean ICISS score: 0.997 ± 0.006 SD; discharge to usual residence, mean ICISS score: 0.998 ± 0.008 SD. t-test, $p<0.001$). That is, venomous bite and sting cases that were transferred to another acute hospital were significantly more life-threatening than those which ended in the person being discharged to their place of usual residence. Somewhat surprisingly however, similar comparisons for each category in the range X20–X29 suggest that the severity scores of transferred cases of a particular bite or sting type were not significantly different to cases discharged to their place of usual residence. For example, the mean ICISS score for snakebite cases transferred to another acute hospital was 0.996 ± 0.006 SD compared to 0.996 ± 0.012 SD for snakebite cases separating to the place of usual residence (t-test, $p=0.96$).

Deaths due to venomous bites and stings are infrequent in Australia (Sutherland 1992a; Sutherland & Leonard 1995; White 1998; McGain et al. 2000; Brown et al. 2001; Nimorakiotakis & Winkel 2003). Many deaths involving venomous creatures appear to be due to anaphylactic reactions to arthropod stings (Harvey et al. 1984; Winkel et al. 1998; McGain et al. 2000; McGain & Winkel 2002) and it is possible that the rate of such deaths is under-estimated due to the difficulty of determination of the cause of death post-mortem (see Riches et al. 2002). Bites from venomous snakes are thought to result in approximately two deaths per year (Sutherland 1992a; Sutherland & Leonard 1995; White 1998). Jellyfish stings, and stings from other marine creatures, can also result in fatalities, although the rate is very low (Nimorakiotakis & Winkel 2003; Fenner 2005).

Only two venomous bite and sting cases in 2002–05 resulted in the death of the patient while in hospital and one more death was recorded for a separation classed as an inward transfer and excluded from the main analysis. Two of these three deaths involved venomous snakes (of the brown and tiger snake immunotypes) while the remaining fatal hospitalisation was attributed to a box jellyfish. A further seven deaths were identified when ABS mortality records were analysed. These death records had underlying causes of death attributing the death to venomous spiders (X21, n=2), hornets, wasps or bees (X23, n=3) and venomous marine creatures (X26, n=2). It is thought that the absence of a hospital record for these cases indicates that the bite/sting was rapidly fatal.

Table 8: Mode of separation for hospitalised bite and sting cases (X20–X29): males, females and persons, 2002–05

Mode of separation	Males	Females	Persons
Unknown/not supplied	* (0.0%)	0 (0.0%)	* (0.0%)
Transfer to another acute hospital	339 (4.6%)	161 (3.8%)	500 (4.3%)
Transfer to residential aged care service	* (0.0%)	* (0.0%)	* (0.0%)
Transfer to psychiatric hospital	* (0.0%)	* (0.0%)	* (0.0%)
Transfer to other health care accommodation	15 (0.2%)	10 (0.2%)	25 (0.2%)
Statistical discharge: type change	10 (0.1%)	15 (0.4%)	25 (0.2%)
Discharged at own risk	136 (1.9%)	44 (1.0%)	180 (1.6%)
Statistical discharge: from leave	* (0.1%)	* (0.0%)	7 (0.1%)
Died	* (0.0%)	* (0.0%)	* (0.0%)
Other (usual residence)	6,832 (93.0%)	4,025 (94.5%)	10,857 (93.6%)
Total	**7,343**	**4,259**	**11,602**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

Table 9: Type of bite and sting incident resulting in a mode of separation of 'transfer to another acute hospital': males, females and persons, 2002–05

External cause	Males	Females	Persons
Contact with venomous snakes and lizards (X20)	182 (53.7%)	82 (50.9%)	264 (52.8%)
Contact with spiders (X21)	71 (20.9%)	34 (21.1%)	105 (21.0%)
Contact with scorpions (X22)	* (0.0%)	* (0.6%)	* (0.2%)
Contact with hornets, wasps and bees (X23)	26 (7.7%)	14 (8.7%)	40 (8.0%)
Contact with centipedes and venomous millipedes (tropical) (X24)	* (0.0%)	* (0.6%)	* (0.2%)
Contact with other specified venomous arthropods (X25)	13 (3.8%)	17 (10.6%)	30 (6.0%)
Contact with venomous marine animals and plants (X26)	38 (11.2%)	10 (6.2%)	48 (9.6%)
Contact with other specified venomous animals (X27)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Contact with other specified venomous plants (X28)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Contact with unspecified venomous animal or plant (X29)	* (2.7%)	* (1.2%)	11 (2.2%)
Total	**339**	**161**	**500**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

1.2 Hospitalised bite and sting trends 1999–05

From 1st July 1999 all Australian hospital separations have been coded to the Australian Modification of the tenth revision of the International Classification of Diseases (ICD-10-AM, see Helps et al. 2002). While some changes to the codes have occurred in later editions of the ICD-10-AM (chiefly the inclusion of more specific subcategories), the basic structure of the external cause codes relevant to bites and stings from venomous species have been maintained, which allows trends over time to be assessed.

A total of 23,972 hospitalised cases due to bites and stings from venomous animals and plants were identified for the six year period 1st July 1999 to 30th June 2005. As previously described, these cases were identified as those separations having a first external cause in the range X20–X29 and a mode of admission other than a transfer from another acute hospital (to address the issue of multiple counting).

The overall incidence of hospitalised bites and stings (X20–X29) appears to have fallen slightly over the six-year study period (Figure 5, dashed lines). The age-standardised rate of bite and sting cases was 21.1 per 100,000 persons in 1999–00 while in 2004–05 this rate was 19.0 per 100,000.

However, a distinct step-wise decline in the rate of hospitalised bites and stings (X20–X29) is observed between 2001–02 and 2002–03, which coincides with the introduction of the third edition of the ICD-10-AM. While this edition of the classification did not make any substantial changes to the X20–X29 base code range, three sub-categories were introduced for the previously undivided W59, bitten or crushed by other reptiles. These sub-categories are: W59.0, bitten or crushed by non-venomous snake; W59.1, bitten or crushed by snake, unknown whether venomous or non-venomous, and W59.8, bitten or crushed by other specified reptile (NCCH 2002). The rate of incident cases (as before, separations omitting inward transfers) coded with a principal external cause of W59 increased markedly after the introduction of the expanded categories (Figure 6).

Furthermore, specific coding standards regarding the coding of snakebites were also introduced in the third edition of the ICD-10-AM (NCCH 2002). These coding standards provide unambiguous instruction on how to code bites from venomous snakes which do not involve envenomation, bites which do involve envenomation and the administration of anti-venom and bites from non-venomous snakes and snakes of unknown toxicity. Thus, in addition to having more specific snake-related external cause codes available, clinical coders also had more specific coding instructions to guide their work. This may also have influenced the manner in which snakebites were classified and the apparent changes in the rates observed.

Re-analysis of hospitalised bites and stings to include incident cases principally attributed to W59.1 from 2002–03 (the only pertinent W59 subcategory, n=1,570) resulted in the stabilisation of rates attributed to bites and stings from (potentially) venomous animals and plants (Figure 5, solid lines). As such, it appears that the apparently decreasing trend in the rate of hospitalised cases attributed to bites and stings from venomous animals and plants (X20–X29) is an artefact of the W59 coding changes, rather than an actual decline in the rate of serious bites and stings.

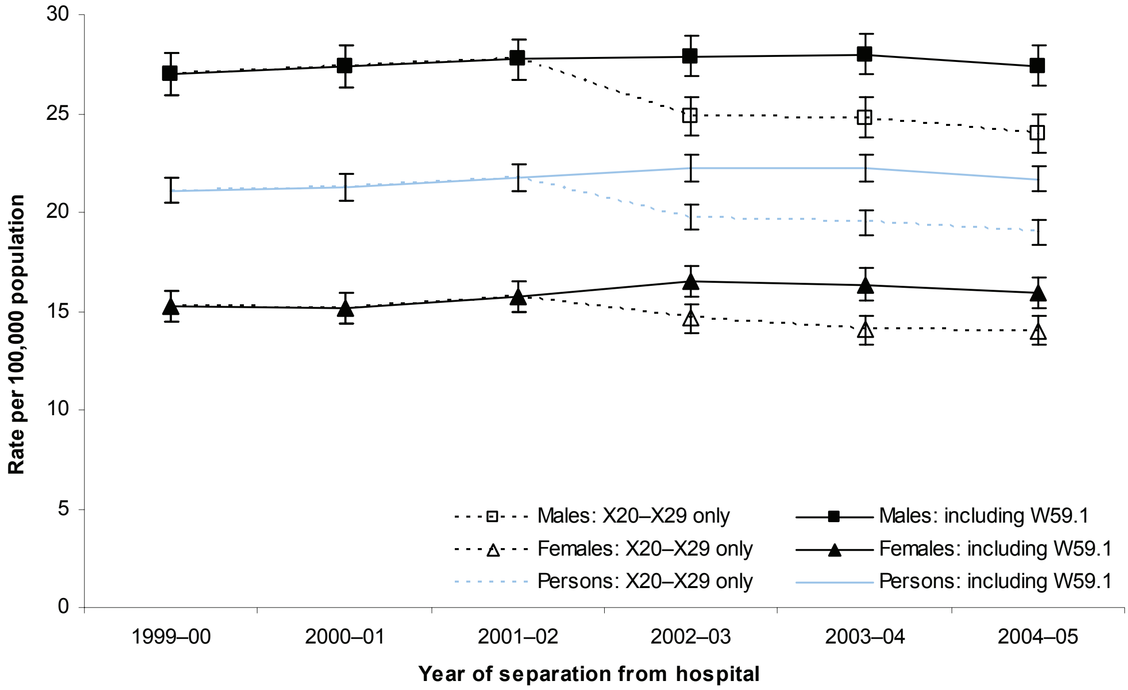


Figure 5: Age-standardised rates (± 95% CI) for hospitalised venomous bite and sting cases (X20–X29) and X20–X29 plus W59.1 (snakes of unknown toxicity) cases over time: males, females and persons, Australia 1999–05

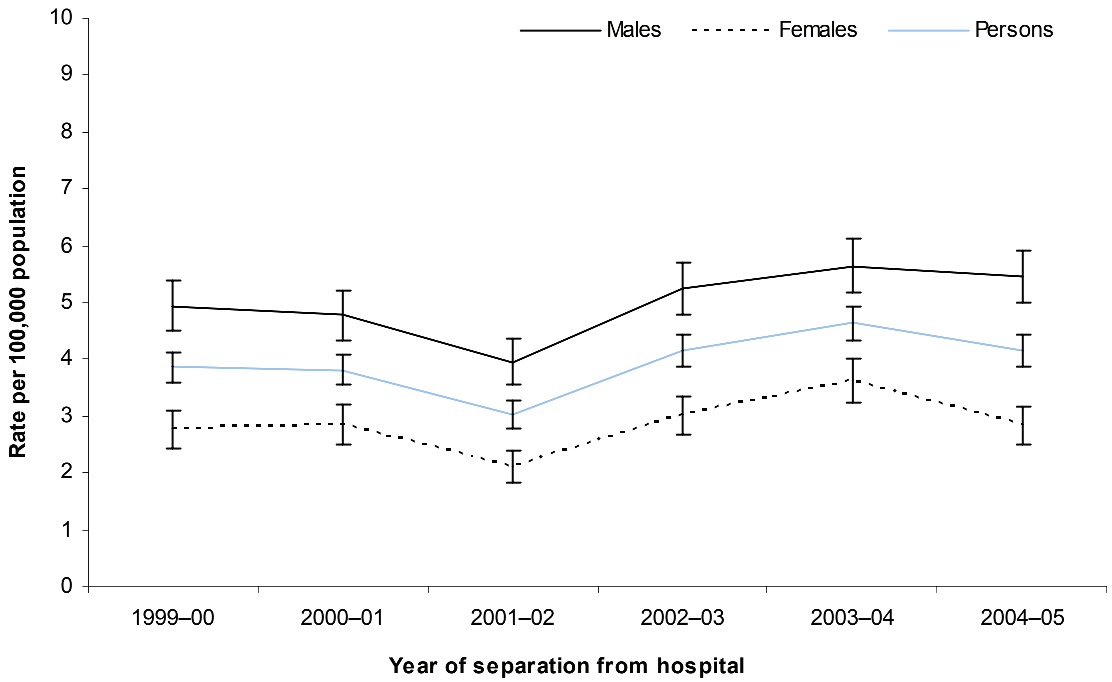


Figure 6: Age-standardised rates (± 95% CI) for cases with a prinicipal diagnosis of W59, bitten or crushed by other reptiles: males, females and persons, Australia 1999–05

1.2.1 State and territory trends

This study also examined the rate of hospitalised bite and sting cases according to the person's state of usual residence and due to the previous results, analysis included cases coded to W59.1 from 2002–03 (X20–X29 or W59.1; n=25,227).

The rates of hospitalised bites and stings (X20–X29 plus W59.1 from 2002–03) for residents of each state and territory were largely stable over the six year study period. Similar to the results presented in section 1.1.2, in most years of the study period rates of bite and sting cases were highest for residents of Queensland (Figure 7) and lowest for residents of the ACT (Figure 8, figures to same scale). Some fluctuation in rates from year to year was noted, but generally the rates appeared to be stable over time (as indicated by the width of the confidence intervals).

The only jurisdiction for which rates of hospitalised venomous bites and stings appeared to markedly change over time was the Northern Territory. Again, this appears to be a coding issue. When the rates of hospitalised cases involving residents of the Northern Territory were adjusted to include cases coded to W59.1 from 2002–03, a distinct step-wise increase similar, but in the opposite direction, to that noted nationally was observed (Figure 9, note the change in scale). Conversely, the rate of X20–X29 cases (without W59.1 cases) involving residents of the Northern Territory remained stable over time. As such, it appears that the coding protocols prescribing the designation of either X20.0 or W59.1 codes from 2002–03 may not have been applied in this jurisdiction as they have in the other states and territories of Australia.

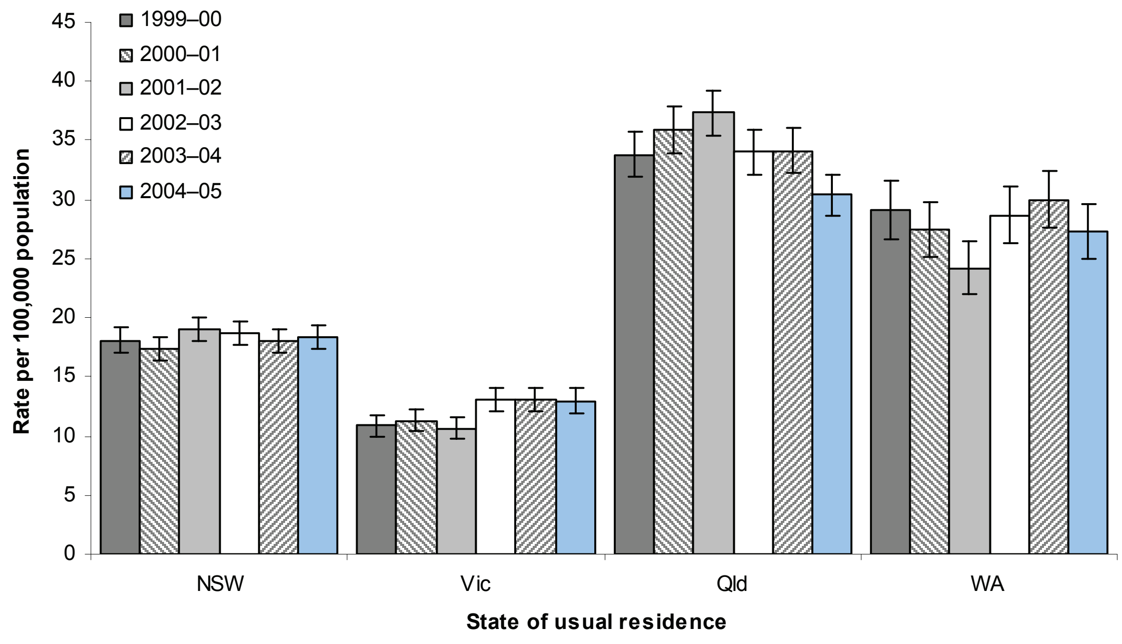


Figure 7: Age-standardised rates (± 95% CI) for hospitalised cases (X20–X29) 1999–05, plus W59.1 cases from 2002–03: persons resident in New South Wales, Victoria, Queensland and Western Australia

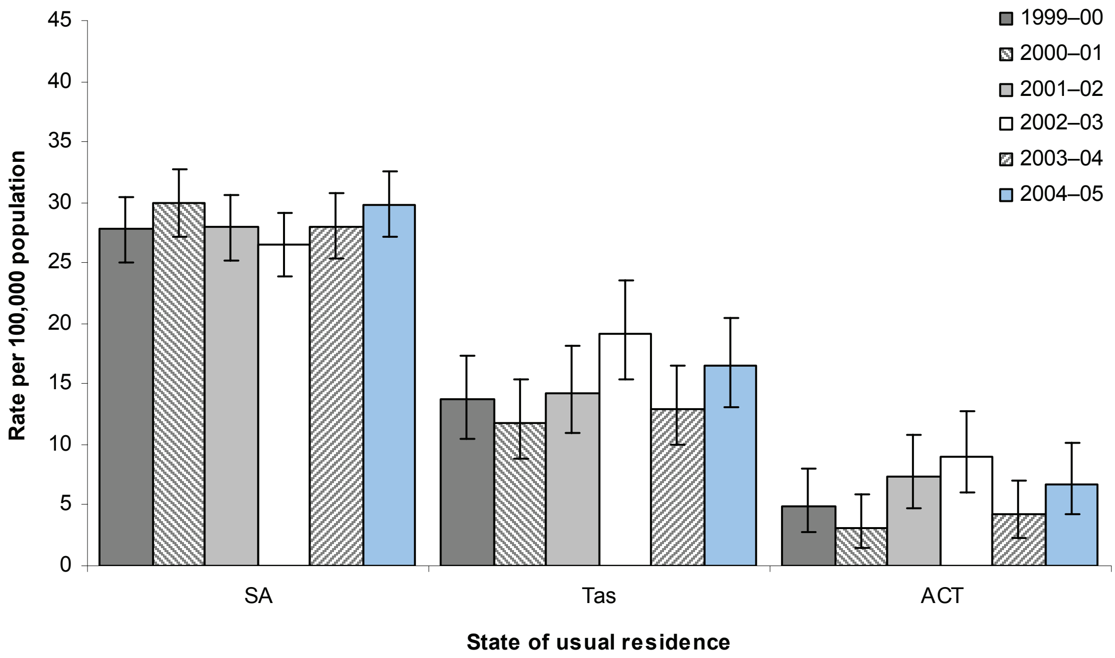


Figure 8: Age-standardised rates (± 95% CI) for hospitalised cases (X20–X29) 1999–05, plus W59.1 cases from 2002–03: persons resident in South Australia, Tasmania and the ACT

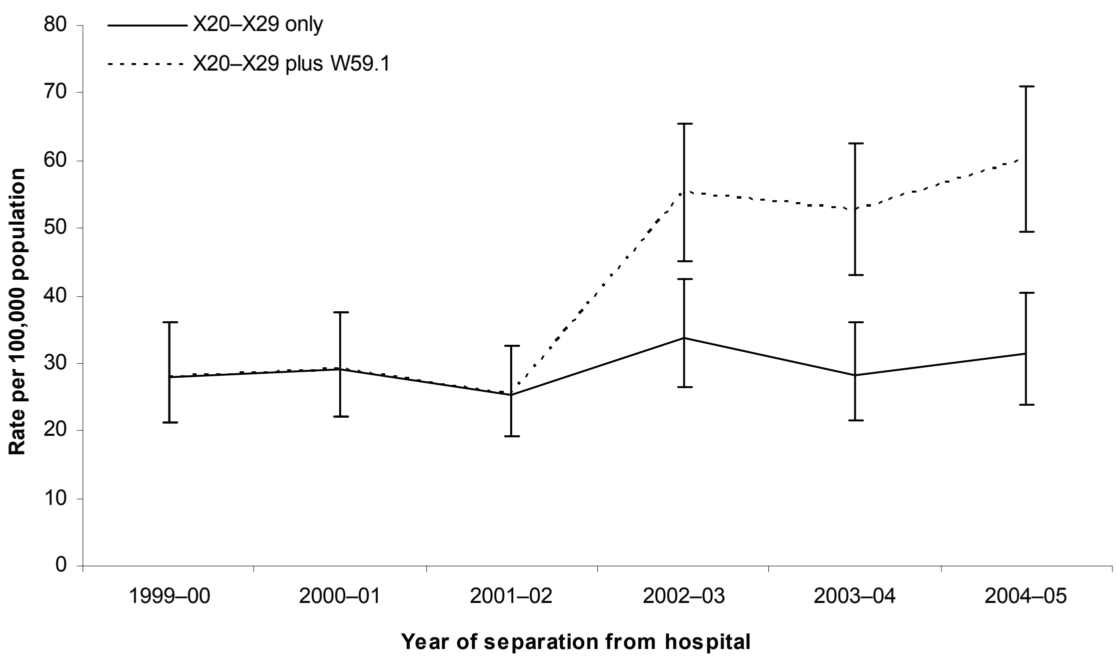


Figure 9: Age-standardised rates (± 95% CI) for hospitalised cases (X20–X29) 1999–05, ± W59.1 cases from 2002–03: persons resident in the Northern Territory

1.2.2 Remoteness trends

Analysis of the trends over time for rates of hospitalised bites and stings according to the person's remoteness of usual residence was also undertaken. Again, cases coded to W59.1 were included for the period commencing 2002–03. Data availability limited this analysis to the five-year period 1st July 2000 to 30th June 2005 (n=21,208).

The pattern of the rate of hospitalised bite and sting cases described in section 1.1.3 above, being lowest for residents of Australia's major cities and highest for residents of Australia's remote and very remote regions, was evident in each single year of the study period (Figure 10). Further, rates for residents of Australia's major cities and inner regional areas appeared to be stable between 2000-01 and 2004–05. Rates of bite and sting cases involving people resident in Australia's outer regional areas appear to have significantly increased over the study period however.

Rates of bite sting cases involving residents of Australia's remote and very remote regions were higher than for other areas of Australia in each single year of the study period, but not significantly different from each other. An insignificant decrease in rates involving residents of Australia's remote regions was observed between 2000–01 and 2004–05 while rates involving residents of Australia's very remote regions fluctuated widely from year to year without any discernable trend. These results may have been influenced by the application, or not, of the W59.1 code for residents of the Northern Territory (see previous section), most of which is classed as remote or very remote (ABS 2001). Even so, analysis undertaken using cases coded to W59.1 for all states and territories except for the Northern Territory revealed that the influence of the coding difference was only one of magnitude rather than trend (see Figure 11, shown to same scale as Figure 10).

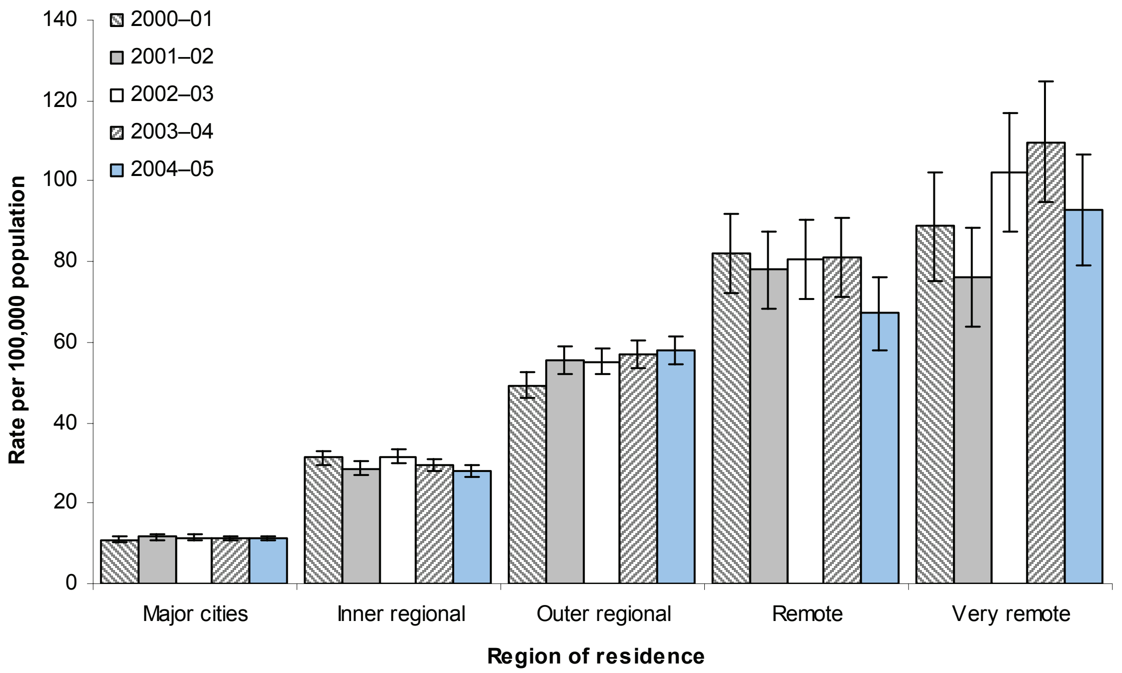


Figure 10: Age-standardised rates (± 95% CI) for hospitalised cases (X20–X29) between 2000–05, plus W59.1 cases from 2002–03, by remoteness of usual residence

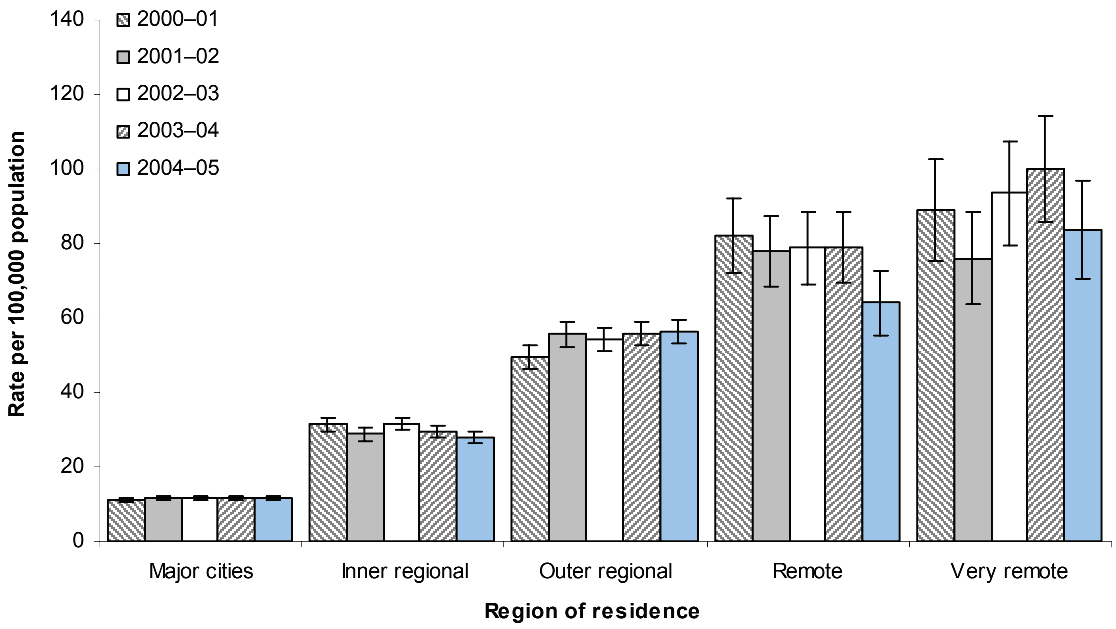


Figure 11: Age-standardised rates (± 95% CI) for hospitalised cases (X20–X29) between 2000–05, plus W59.1 cases from 2002–03 (except for residents of the Northern Territory), by remoteness of usual residence

2 Snakes

Contact with venomous snakes and lizards (X20) was listed as the first external cause for 1,751 bite and sting cases between 1st July 2002 and 30th June 2005 (an average of 583.3 cases per year). This represented 15.1% of all hospitalised bite and sting incidents coded to X20–X29 in this period. The venom toxicity of Australian lizard species is not fully understood (see Fry et al. 2006), but none of the endemic lizards have been confirmed to be venomous to humans. As such, hospital records coded with an external cause of X20.1 generally involve herpetologists and/or animal husbandry professionals who interact with captive exotic species. Only one such incident case (0.06%) was identified in the three year study period. This case has been excluded in the following analyses.

In light of the examination of trends over time for hospitalised bite and sting cases in the previous chapter (section 1.2), it was considered important to also include incident cases coded to W59.1, bitten or crushed by snake, unknown whether venomous or non-venomous, in this analysis. However, as the previous analyses also suggested that the W59.1 coding change had not been utilised in the Northern Territory, only X20.0 cases were included for this jurisdiction (based on state of hospitalisation).

In the period 1st July 2002 and 30th June 2005 1,394 W59.1 cases were identified for jurisdictions other than the Northern Territory—almost as many cases as the number unambiguously attributed to venomous snakes (total n=3,144). For simplicity, in this chapter the term 'snakebite' will be used to mean cases involving snakes that were possibly (W59.1) or definitely (X20.0) venomous. Bites by snakes that were definitely non-venomous (W59.0) are not included.

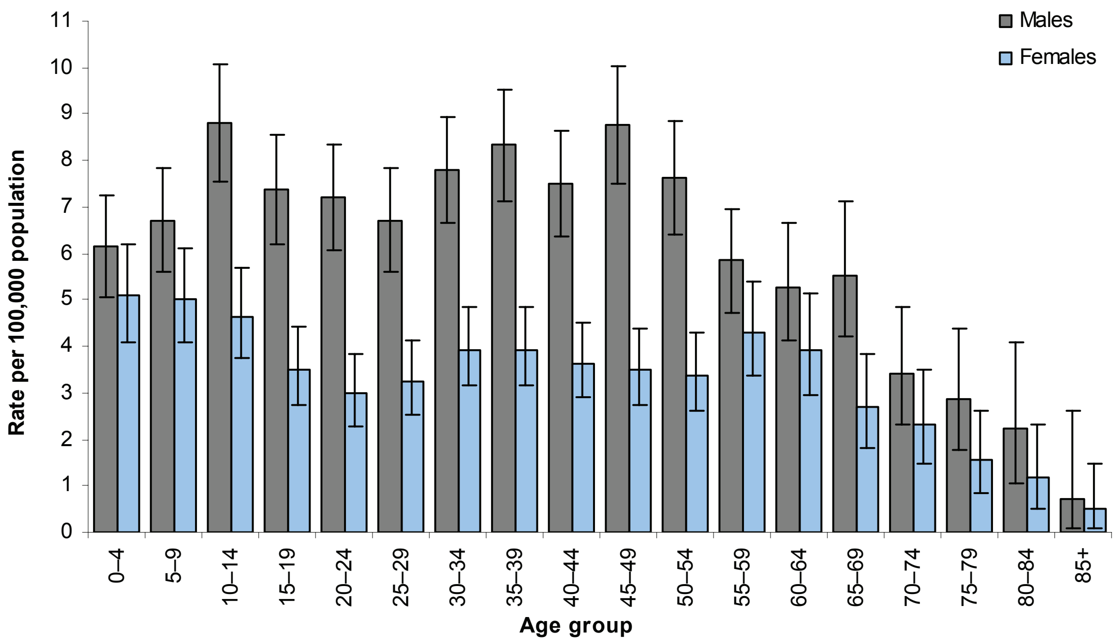


Figure 12: Age-specific rates (± 95% CI) for hospitalised snakebite cases (X20.0, or W59.1 except in NT): males and females, Australia 2002–05

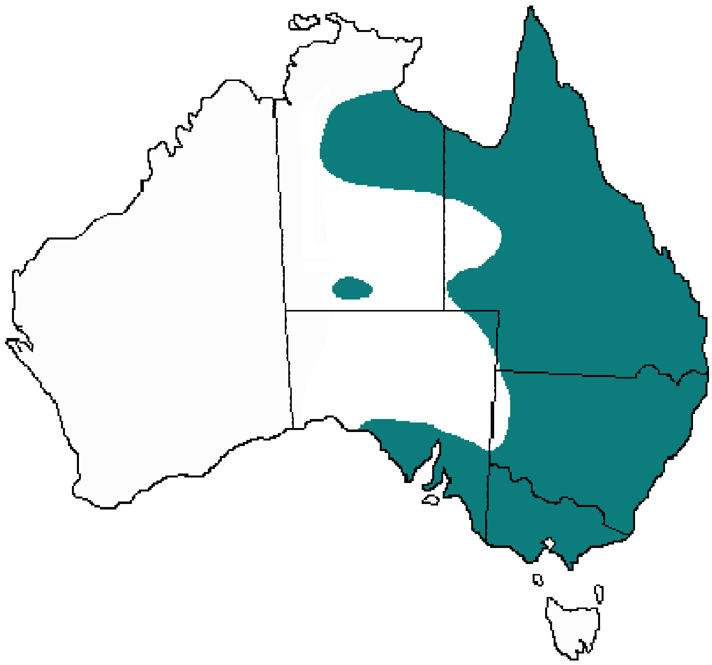
The age-standardised rate of snakebite cases separating from hospital between 1st July 2002 and 30th June 2005 was 5.3 per 100,000 population. As for all bites and stings, most hospitalised snakebite cases involved males (65.3%, n=2,054). The age-standardised rate of snakebite for males was 6.9 per 100,000 population compared to 3.7 per 100,000 for females—a rate ratio of 1.9 to 1. Males also had a higher rate of snakebite than females in every age group (Figure 12). Rates were generally highest for children and middle-aged adults and rates declined at older ages.

2.1 Cases by type of snake, 2002–05

As outlined above, 1,750 cases (X20.0, 55.7%) in the 2002–05 study period were attributed to bites by venomous snakes while 1,394 cases were attributed to bites by snakes of unknown toxicity in jurisdictions other than the Northern Territory (W59.1, 44.3%). A higher proportion of cases involving males were attributed to definitely venomous snakes (57.9%) than for cases involving females (51.5%, Table 10). The age-standardised rate of bites attributed to venomous snakes for the three-year study period was 2.9 per 100,000 population while the age-standardised rate of bites attributed to snakes of unknown toxicity was 2.3 per 100,000. The rate of bites involving males was higher than that for females for both types of snakebite.

In addition to the expanded coding for the W59 category already discussed, recent revisions of the ICD-10-AM include sub-categories which allow the type of venomous snake involved in an incident to be coded, where this is known (NCCH 2002). Most identifications likely result from the use of a Venom Detection Kit (VDK) or knowledge of the dangerous species present in the particular area (e.g. the only venomous species endemic to Tasmania are the tiger snake and the copperhead). VDKs will confirm the immunotype of the snake, giving a toxicological classification rather than a taxonomic one (e.g. *Hoplocephalus bungaroides*, the broad-headed snake, has the tiger-snake immunotype, White 2001).

Of the hospitalised snakebite cases explicitly attributed to venomous snakes (X20.0) in the 2002–05 study period, more than half were attributed to brown snakes (*Pseudonaja* spp.—53.5%, n=936. See Table 10). Snakes of the brown snake immunotype are widely distributed throughout Australia. The highly venomous eastern brown snake (*Pseudonaja textilis*) is common in the eastern states through to southern South Australia (Figure 13) and the equally dangerous western brown snake (*Pseudonaja nuchalis*) common throughout most of Australia except the extreme south-west of Western Australia and the eastern seaboard (Cogger 2000). Other species of brown snake (e.g. *Pseudonaja inframacula*) are also considered dangerous, but have more limited distributions (Cogger 2000). Hospitalised cases involving brown snakes in the 2002–05 study period occurred at an age-standardised rate of 1.6 per 100,000 population nationally. Males experienced a higher rate of cases involving brown snakes (2.0 per 100,000 population) than females (1.1 per 100,000).



Source: Image courtesy Australian Venom Research Unit (AVRU).

Figure 13: Distribution of the eastern brown snake, *Pseudonaja textilis*

Source: Image courtesy AVRU.

Figure 14: Distribution of the western brown snake or gwardar, *Pseudonaja nuchalis*

While often referred to as the 'king brown' snake (or mulga snake), *Pseudechis australis* is actually a black snake and is widely distributed throughout most of Australia (Figure 15). Bites by snakes of the black snake immunotype were the second most common type of venomous snakebite over the 2002–05 study period (14.6%, n=256). Black snake bites also include cases involving the red-bellied black snake (*Pseudechis porphyriacus*), a dangerous snake common in stream, swamp and lagoon habitats throughout eastern Australia to southern South Australia (Cogger 2000). Some less common black snake species are also dangerous to humans (e.g. *Pseudechis colletti*, Isbister et al. 2006; *Pseudechis guttatus*, Jansen et al. 2006).

The age-standardised rate of cases involving black snakes was 0.4 cases per 100,000 population nationally. Again, males had a higher rate of black snakebites (0.6 per 100,000, n=190) than females (0.2 per 100,000). The actual rate of black snake bites may be higher than this due to some bites possibly returning a VDK result positive for tiger snake venom and tiger snake anti-venom being the preferred treatment for envenomation resulting from contact with some black snake species (White 2001, thus such bites may be feasibly recorded as tiger snake bites in separation records).

Snakes of the tiger snake immunotype (principally *Notechis* spp.) represent a serious threat to humans and were implicated in 11.4% of venomous snakebite cases hospitalised in 2002–05 (n=199). The tiger snake immunotype also includes the rough-scaled snake, *Tropidechis carinatus*, copperheads, *Austrelaps* spp., and broad-headed snakes, *Hoplocephalus* spp., and, as mentioned above, some snakebites treated as tiger snake bites may be bites involving some species of black snake. Nonetheless, the age-standardised rate of cases involving tiger snakes was quite low (0.3 per 100,000 population).

Tiger snakes (*Notechis* spp.) are found in a wide range of habitats throughout the southern Australian mainland, offshore islands and Tasmania (Cogger 2000). The other species included in the immuntotype are much less common and/or restricted in their geographical distribution (Cogger 2000; White 2001). Tiger snakes were previously considered to represent the greatest threat to humans, being responsible for a large proportion of recorded snakebite fatalities (e.g. Sutherland 1983). Also, tiger snake antivenom was the most commonly used monovalent antivenom in 1989–1990, as reported to the Commonwealth Serum Laboratories (Sutherland 1992b). Our analysis, however, supports more recent assessments which conclude that tiger snakes no longer contribute the largest proportion of serious snakebites in Australia (White 1998; White 2000; Currie 2006). Reasons for this are unclear; it has been suggested that the habitat disturbance and/or the increased use of glyphosate herbicides (and their consequent impact on frog populations, one of the main prey items for tiger snakes) have severely reduced *Notechis* spp. populations (Peter Mirtschin, Venom Supplies Pty. Ltd. pers. comm. 2007). Little is known about current tiger snake population numbers however, but the habitat destruction theory, in conjunction with the current dry-weather cycle, is anecdotally supported by ecologists in the western (South Australian) portion of *N. scutatus'* range (Peter Alexander, Mark Bachmann & Daniel Harley, Department of Environment and Heritage, South Australia. pers. comm. 2007). Further, many of the other species included in the tiger snake immunotype are listed as nationally vulnerable (to extinction), rare or insufficiently known (Cogger et al. 1993), status that has possibly contributed to the decline in observed 'tiger snake' bites in more recent years.

Source: Image courtesy AVRU.

Figure 15: Distribution of the mulga snake, *Pseudechis australis*

Source: Image courtesy AVRU.

Figure 16: Distribution of the red-bellied black snake, *Pseudechis porphyriacus*

Source: Image courtesy AVRU.

Figure 17: Distribution of the mainland tiger snake, *Notechis scutatus*

Source: Image courtesy AVRU.

Figure 18: Distribution of the black tiger snake, *Notechis ater*

Other notoriously dangerous snakes, such as taipans (*Oxyuranus* spp. including the world's most venomous snake, *Oxyuranus microlepidotus*, Morrison et al. 1983–1984), death adders (*Acanthophis* spp.) and sea-snakes (families Hydrophiidae and Laticaudidae) were responsible for relatively few hospitalised snakebite cases between 2002 and 2005. It is interesting to note that VDKs cannot return an explicit result for sea-snake venom and that tiger snake anti-venom is an appropriate treatment for some sea-snake envenomations (White 2001). As such, some hospitalisations resulting from contact with sea-snakes may have been classed here as tiger snake bites. Rates of hospitalised bite cases involving these specified snakes were equal or less than 0.1 cases per 100,000 for the 2002–05 study period. However, in 11.4% of cases explicitly attributed to venomous snakes (n=200) the type of snake involved remained unspecified, which may have resulted in the under-enumeration of cases caused by particular species.

By definition, the type of snakes involved in cases coded as W59.1 was unknown.

Table 10: Type of snake attributed to hospitalised cases: males, females and persons, Australia 2002–05

External cause	Males	Females	Persons	Per cent X20.0
Contact with brown snake	610 (29.7%)	326 (29.9%)	936 (29.8%)	53.5%
Contact with taipan	* (0.7%)	* (0.5%)	20 (0.6%)	1.1%
Contact with death adder	44 (2.1%)	17 (1.6%)	61 (1.9%)	3.5%
Contact with black snake	190 (9.3%)	66 (6.1%)	256 (8.1%)	14.6%
Contact with tiger snake	148 (7.2%)	51 (4.7%)	199 (6.3%)	11.4%
Contact with sea-snake	* (0.5%)	* (0.3%)	13 (0.4%)	0.7%
Other specified venomous snake	44 (2.1%)	21 (1.9%)	65 (2.1%)	3.7%
Contact with unspecified venomous snake	128 (6.2%)	72 (6.6%)	200 (6.4%)	11.4%
Total X20.0	*1,189 (57.9%)*	*561 (51.5%)*	*1,750 (55.7%)*	
Bitten or crushed by snake, unknown whether venomous or non-venomous (W59.1)	865 (42.1%)	529 (48.5%)	1,394 (44.3%)	
Total	**2,054**	**1,090**	**3,144**	

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

2.2 Principal diagnosis for snakebites

Three-quarters of all hospitalised cases due to contact with venomous snakes (X20.0: 75.5%, n=1,322) in the study period 1st July 2002 to 30th June 2005 were coded with a principal diagnosis meaning 'toxic effect of snake venom' (T63.0). Somewhat surprisingly, more than a third of bite cases attributed to snakes of unknown toxicity (W59.1: 38.5%, n=536) were also given a T63.0 principal diagnosis (Figure 19). In total, 59.1% of all snakebite cases (either X20.0 or W59.1) had a principal diagnosis of T63.0.

A small number of snakebite cases (n=16, 0.5% of the total number of cases coded as either X20.0 or W59.1) were coded to T63 subcategory other than T63.0 (e.g. T63.3, toxic effect of venom of spider, n=5).

Many snakebite cases had a principal diagnosis from elsewhere in the ICD-10-AM's injury and poisoning chapter (35.3%, n=1,110). This was more common for cases coded to W59.1 (55.2%, n=770) than for many types of venomous snakes (Figure 19). Injuries to the ankle and foot (n=548), the knee and lower leg (n=233) and injuries to the wrist and hand (n=204) were common principal diagnoses for injurious snakebite cases. A small proportion of snakebite cases were not coded with an injury principal diagnosis (4.8%, n=160), more than half of which had a principal diagnosis of Z04 (examination and observation for other reasons, n=100).

As can be seen in Figure 19, slightly higher proportions of cases involving death adders and tiger snakes were coded with T63.0 as the principal diagnosis than for bites by other types of snake. The proportion of cases coded with T63.0 as the principal diagnosis was lowest for cases involving contact with sea snakes (46.2%, n=6) and snakes of unknown toxicity (38.5%, n=536).

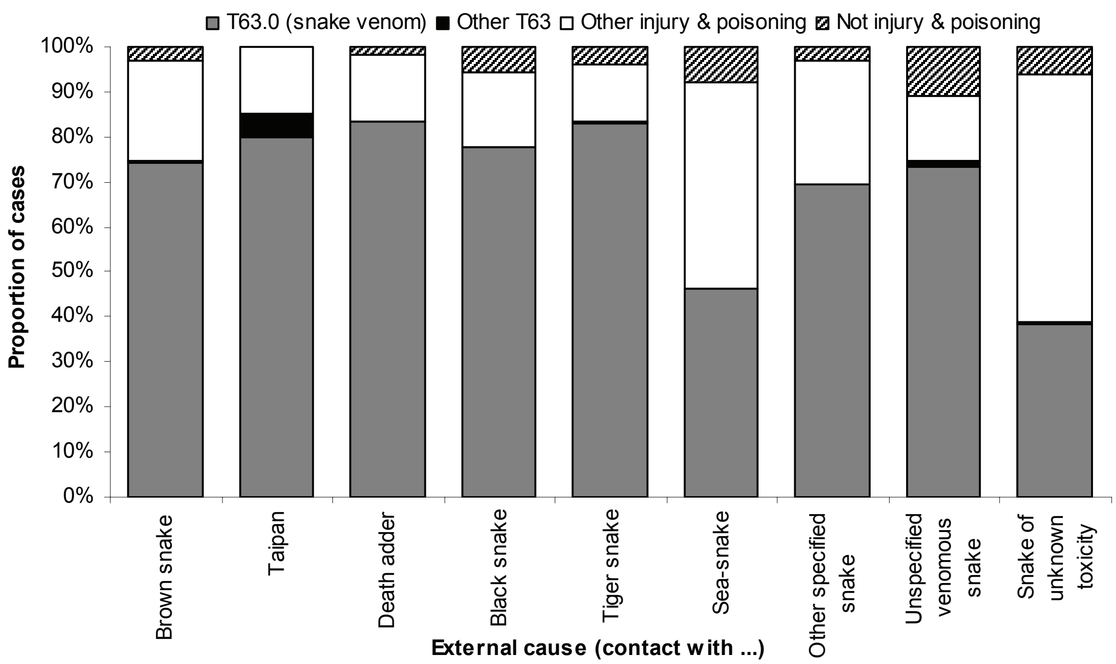


Figure 19: Principal diagnosis for different types of snakebite cases (X20.0–X20.9 or W59.1), Australia, 2002–05

2.3 Place and activity for snakebites

One-third of all hospitalised snakebite cases in 2002–05 took place in and around the home (34.2%, n=1,076. Table 11). This was observed for most types of snakes except for sea-snakes, where only 23.1% of cases occurred in the home. A higher proportion of all snakebite cases involving females (43.4%, n=473) took place in the home than for bites involving males (29.4%, n=603). Farms were also a common place of occurrence for serious snakebites (6.6% of all snakebite cases, n=208). As for all hospitalised bite and sting cases, a large proportion of snakebite cases had a recorded place of occurrence of 'unspecified place' (36.6%, n=1,150).

Table 11: Place of occurrence for hospitalised cases involving contact with snakes (X20.0 or W59.1 except in NT): males, females and persons, Australia 2002–05

Place of occurrence	Males	Females	Persons
Home	603 (29.4%)	473 (43.4%)	1,076 (34.2%)
Residential institution	* (0.4%)	* (0.2%)	11 (0.3%)
School	42 (2.0%)	12 (1.1%)	54 (1.7%)
Health service area	* (0.3%)	* (0.3%)	9 (0.3%)
Other specified institution & public administrative area	* (0.2%)	* (0.2%)	7 (0.2%)
Sports & athletics area	23 (1.1%)	7 (0.6%)	30 (1.0%)
Street & highway	27 (1.3%)	13 (1.2%)	40 (1.3%)
Trade & service area	20 (1.0%)	12 (1.1%)	32 (1.0%)
Industrial & construction area	* (1.3%)	* (0.2%)	28 (0.9%)
Farm	151 (7.4%)	57 (5.2%)	208 (6.6%)
Area of still water	16 (0.8%)	6 (0.6%)	22 (0.7%)
Stream of water	33 (1.6%)	11 (1.0%)	44 (1.4%)
Large area of water	* (0.6%)	* (0.2%)	14 (0.4%)
Beach	21 (1.0%)	14 (1.3%)	35 (1.1%)
Forest	53 (2.6%)	23 (2.1%)	76 (2.4%)
Other specified countryside (including desert)	63 (3.1%)	30 (2.8%)	93 (3.0%)
Other specified place of occurrence	146 (7.1%)	64 (5.9%)	210 (6.7%)
Unspecified place of occurrence	794 (38.7%)	356 (32.7%)	1,150 (36.6%)
Place not reported/not applicable	* (0.2%)	* (0.1%)	5 (0.2%)
Total	**2,054**	**1,090**	**3,144**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

The activity being undertaken at the time of the snakebite was also frequently unspecified for the cases in the study period 1st July 2002 to 30th June 2005 (47.3%, n=1,488. Table 12) and nearly a quarter of all snakebite cases had 'other specified activity' recorded (23.9%, n=750). That is, only 28.5% of records for hospitalised snakebite cases reported activity coding that could be useful for prevention purposes.

About one in ten cases (11.3%) occurred while the person was engaged in unpaid work, such as housework, gardening, chores, DIY etc. An additional 8.3% of snakebite cases occurred while working for income (n=261). More males than females experienced a snakebite that resulted in hospitalisation while working for income (10.9% vs. 3.5% respectively). The most common industry group in which employees were bitten by snakes was the agriculture, forestry and fishing industries group (104 of 261 cases while working for income, 39.8%).

Table 12: Reported activity for hospitalised cases involving contact with snakes (X20.0 or W59.1 except in NT): males, females and persons, Australia 2002–05

Activity	Males	Females	Persons
While engaged in sports	78 (3.8%)	31 (2.8%)	109 (3.5%)
While engaged in leisure	65 (3.2%)	43 (3.9%)	108 (3.4%)
While working for income	223 (10.9%)	38 (3.5%)	261 (8.3%)
While engaged in other types of work	220 (10.7%)	135 (12.4%)	355 (11.3%)
While resting, sleeping, eating, etc.	28 (1.4%)	34 (3.1%)	62 (2.0%)
Other specified activity	471 (22.9%)	279 (25.6%)	750 (23.9%)
Unspecified activity	961 (46.8%)	527 (48.3%)	1,488 (47.3%)
Total *	**2,054**	**1,090**	**3,144**

* Totals include 11 cases for which activity was not reported.

2.4 Length of stay for snakebite cases

The mean length of stay for hospitalised snakebite cases in the period 2002–05 was generally low. For all types of snakebite cases, the mean length of stay was 1.2 days (± 2.5 SD). Mean length of stay for snakebite cases involving males was only slightly longer, (1.3 days ± 3.0 SD) than that for females (1.1 days ± 0.9 SD), but was more variable. This may be related to differences in the type of snakes involved in the cases; bites involving taipans and bites involving tiger snakes had longer mean lengths of stay (Figure 20) and three-quarters of these cases involved males (74–75% of these cases as opposed to 65.3% of snakebite cases overall).

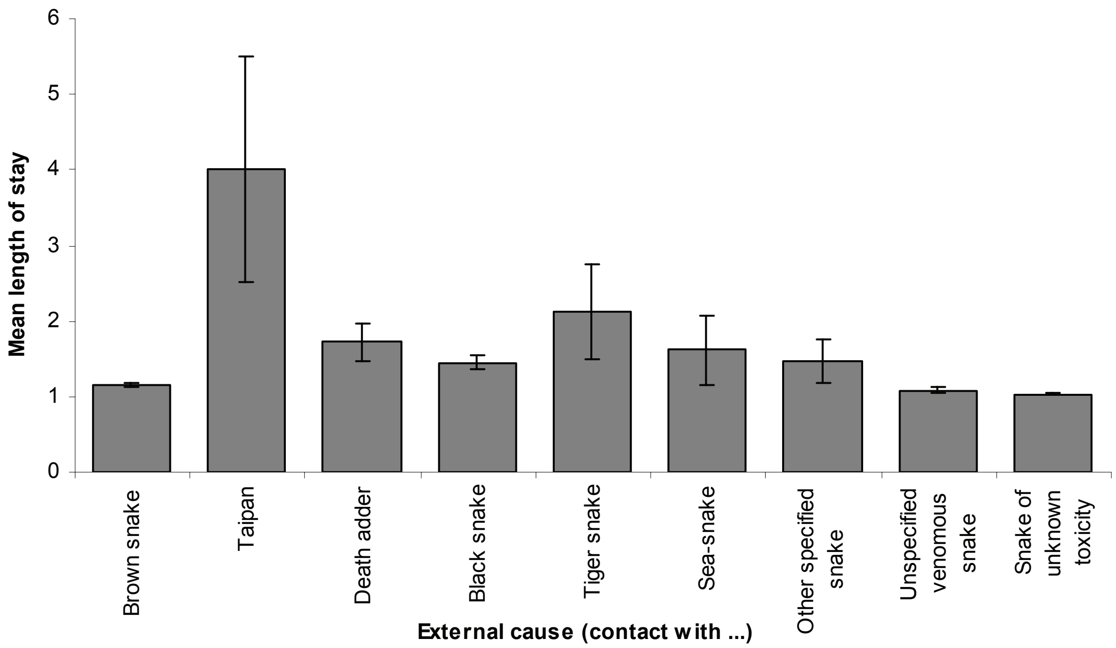
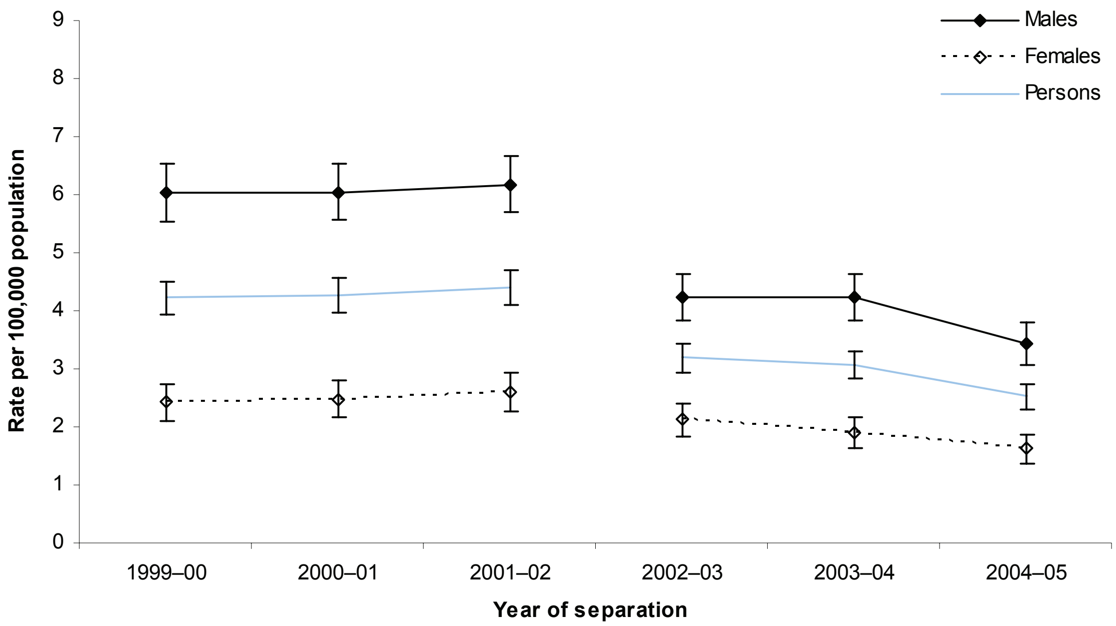


Figure 20: Mean length of stay (days ± SE) for hospitalised snakebite cases (X20.0 or W59.1 except in NT), Australia, 2002–05

2.5 Trends in rates of hospitalised snakebites

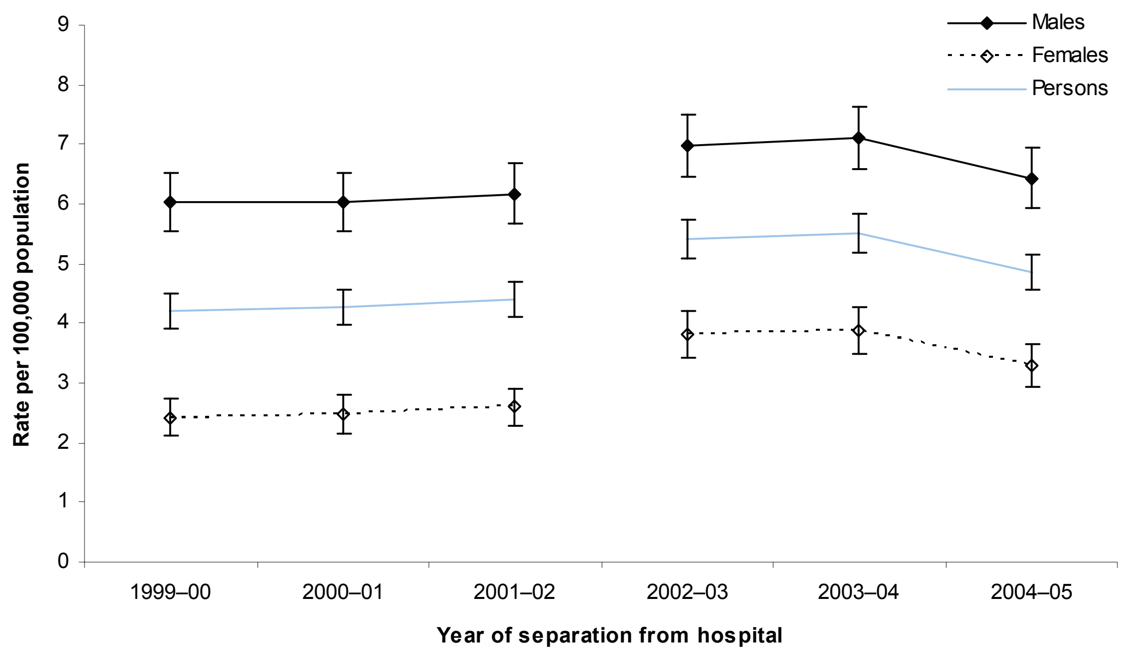
All separations with a first external cause of X20 (contact with venomous snakes and lizards) with a mode of admission other than transfer from another acute hospital were analysed for the period 1st July 1999 to 30th June 2005 (n=4,237). Prior to the 1st July 2002, bites due to contact with venomous lizards could not be distinguished from bites due to contact with venomous snakes. As only one case of a bite from a venomous lizard was reported in the 2002–05 data, the proportion of X20 cases in the 1999–05 study period that were due to contact with lizards is presumed to be very small. Given the results of the previous analyses of trends over time for all bite and sting cases (section 1.2), cases coded with a first external cause of W59.1 in jurisdictions other than the Northern Territory were also included here from 1st July 2002 (n=1,344). A total of 5,630 records was analysed for the six-year study period.

Similar to the results provided in section 1.2, omitting cases coded to W59.1 from July 2002 provoked an obviously spurious result in that rates of hospitalised cases attributed to X20 (explicitly venomous snakes) declined significantly and abruptly (Figure 21). On the other hand, the inclusion of W59.1 cases from jurisdictions other than the Northern Territory rates of hospitalised snakebite increased slightly from 2002–03 (Figure 22). It is thought that this increase is due to the inevitable inclusion of bites due to contact with (unconfirmed) non-venomous species in the W59.1 category. As can be seen in Figure 22, the width of the confidence intervals for the rate of hospitalised snakebite cases suggests that the increase observed upon the inclusion of W59.1 cases in 2002–03 was not significant and, as such, that the rates of snakebite cases over time remained relatively stable.



Note: **Break in series indicates change to third edition ICD-10-AM coding.**

Figure 21: Age-standardised rates (± 95% CI) over time for cases explicitly attributed to venomous snakes and lizards (X20): males, females and persons, 1999–05



Note: Break in series indicates change to third edition ICD-10-AM coding.

Figure 22: Age-standardised rates (± 95% CI) over time for cases with a first external cause of X20 or W59.1 (except in NT): males, females and persons, 1999–05

The rate of hospitalised cases involving contact with definitely or possibly venomous reptiles in the period 1999–05 varied widely according to the person's state of usual residence, although rates in each state appeared to remain stable over time. Annual age-standardised rates of hospitalised snakebite cases were generally highest for residents of Queensland (range: 8.9—11.6 per 100,000, see Figure 23). The inclusion of W59.1 cases from 1st July 2002 served to increase rates slightly, but the width of the confidence intervals again suggests that this was not significant. The lowest rates of hospitalised snakebite cases in each year of the study period were observed for residents of the Australian Capital Territory (range: 0.0—1.5 per 100,000, see Figure 24).

As for all hospitalised bite and sting cases, the annual rate of cases attributed to definitely or possibly venomous snakes and lizards for the 2000–05 period was lowest for residents of major cities (0.8—1.7 per 100,000 population) and, generally, highest for residents of Australia's very remote areas (20.2—37.4 per 100,000). Cases coded as W59.1 hospitalised in jurisdictions other than the Northern Territory were included in the analysis from 1st July 2002. This appeared to have the greatest impact on rates of snakebite involving residents of Australia's very remote regions (Figure 25). Case numbers for this region were small overall (less than 68 cases nationally per year), so may have been more affected by the unavoidable inclusion of W59.1 cases that actually involved non-venomous species. Nevertheless, the width of the confidence intervals for these rates suggests that the observed increase in rates over time was not significant. Rates of hospitalised snakebite remained stable over time for all remoteness regions, except for residents of outer regional areas where a significant increase between 2000–01 and 2004–05 was observed.

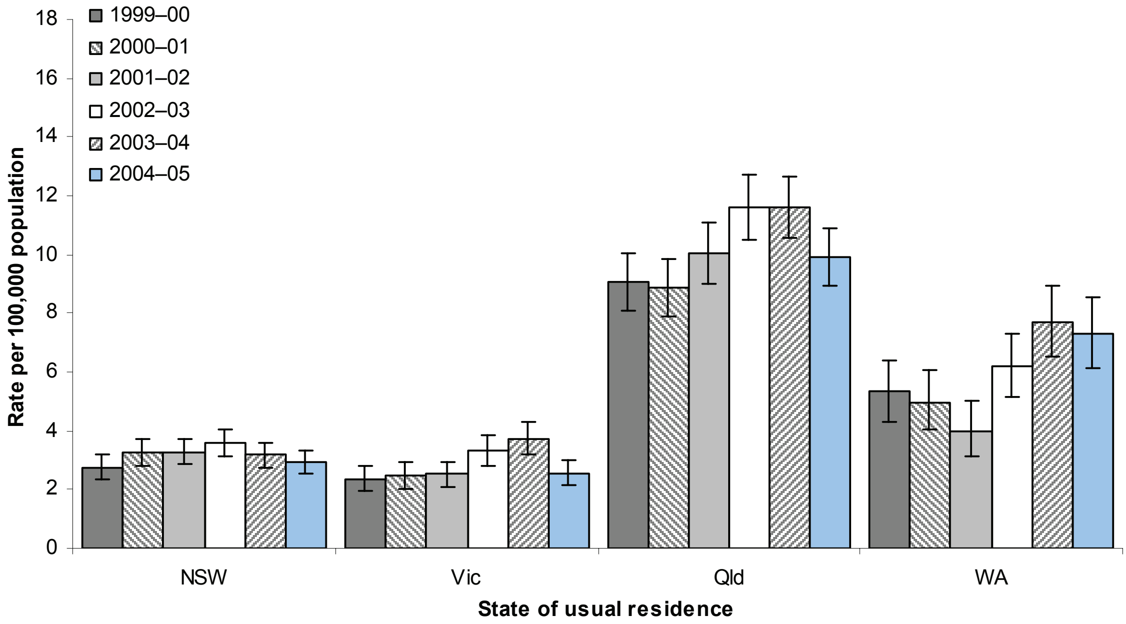


Figure 23: Age-standardised rates (± 95% CI) for cases with a first external cause of X20 or W59.1 by year and state of usual residence; New South Wales, Victoria, Queensland and Western Australia, 1999–05

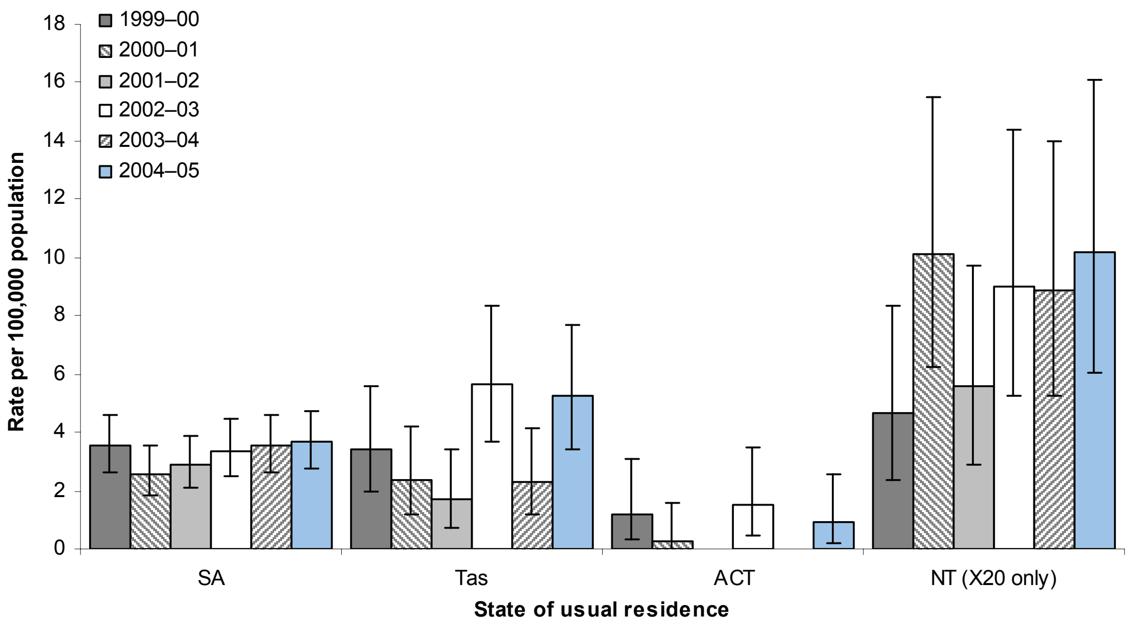


Figure 24: Age-standardised rates (± 95% CI) for cases with a first external cause of X20 or W59.1 (except in NT) by year and state of usual residence; South Australia, Tasmania, Australian Capital Territory and the Northern Territory, 1999–05

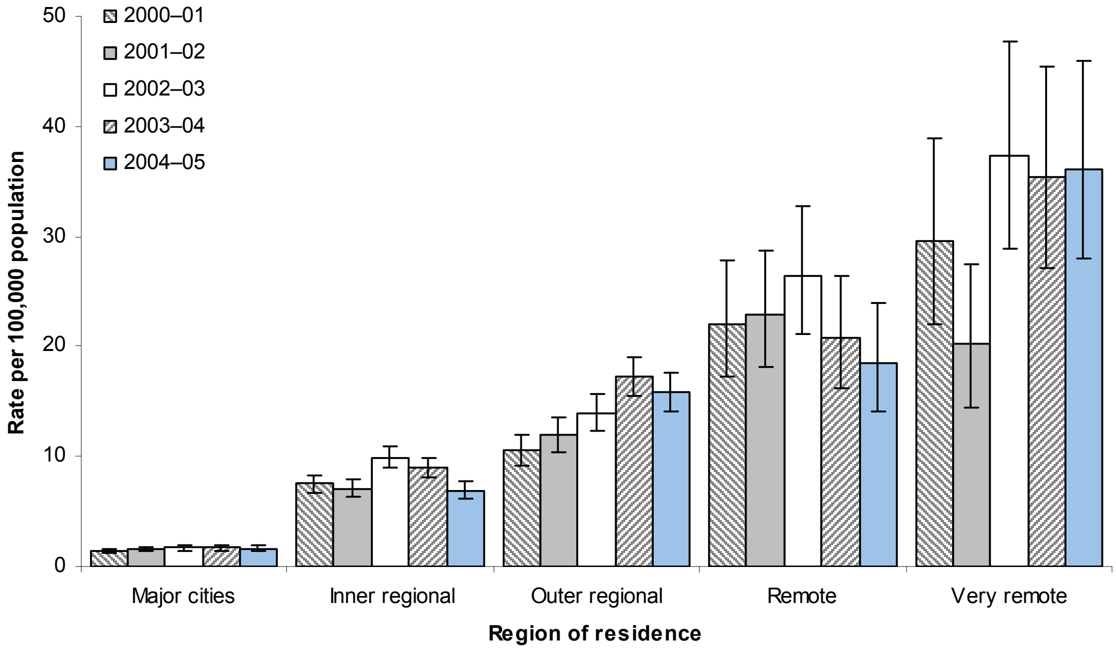


Figure 25: Age-standardised rates (± 95% CI) for cases involving definitely or possibly venomous snakes and lizards (X20 or W59.1) over time, by remoteness of usual residence; Australia 2000–05

3 Spiders

Contact with spiders (X21) was the most common external cause type for hospitalised bite and sting cases between 1st July 2002 and 30th June 2005, being listed as the first external cause for 3,887 cases. This represents a third of all venomous bites and stings in this period (33.5%). The average number of spider bites cases for 2002–05 was 1,295.7 per year.

The age-standardised rate of hospitalised spider bites during the study period was 6.5 per 100,000 population, more than twice that of venomous snakes. Unlike many other types of venomous bites and stings (refer to Table 2), males and females were hospitalised for spider bites in a relatively equal proportion; 54.5% of the cases involved males (n=2,117). The age-standardised rate of spider bite cases for males was 7.1 per 100,000 population while for females, this rate was 5.9 per 100,000. This equates to a rate ratio of 1.2 to 1. The age-specific rates of cases involving spider bites are generally similar for both males and females and highest in adults between the ages of 20 and 54 years (Figure 26).

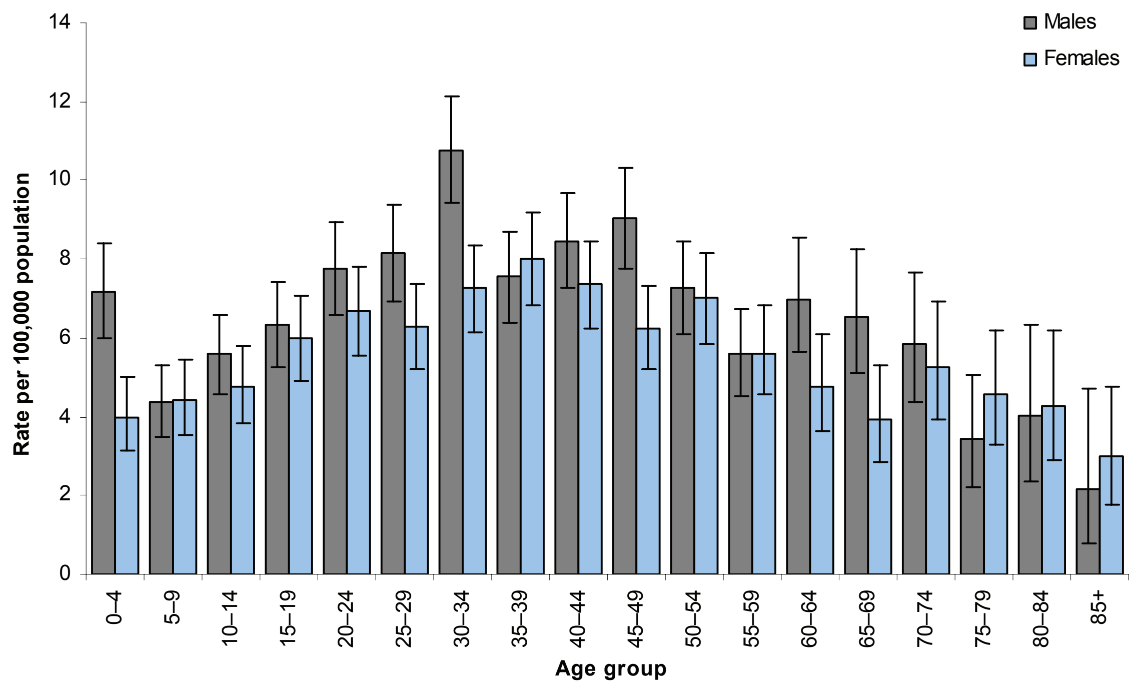


Figure 26: Age-specific rates (± 95% CI) for hospitalised cases involving spiders (X21): males and females, Australia 2002–05

3.1 Cases by type of spider

Provisions to code the particular type of spider involved in a bite or sting hospitalisation have been available in the ICD-10-AM since the classification's third edition (NCCH 2002). Between 1st July 2002 and 30th June 2005, most cases of hospitalised spider bites were attributed to redback spiders (persons: 58.6%, n=2,277. See Table 12). While most of these cases are thought to involve the Australian redback spider (*Latrodectus hasselti*), this category also includes bites by the brown widow (*L. geometricus*), cupboard (*Steatoda* spp.), katipo and black widow spiders (also *Latrodectus* spp.). *Latrodectus hasselti* is found throughout Australia (Figure 27), but is most common in the temperate regions of the nation. Similarly, cupboard/false widow spiders are common, particularly in urban areas (Nimorakiotakis & Winkel 2004). The Australian distribution of the brown widow spider is more limited than the former species and katipo and black widow spiders are not thought to be present in Australia (Garb et al. 2004), unless housed in captive collections. The age-standardised rate of redback spider bites for the 2002–05 study period was 3.8 per 100,000 population.

The second most common type of spider implicated in bite cases were white-tailed and other necrotising spiders (7.3%, n=282), a far smaller number of cases than those attributed to redbacks. In addition to white-tailed spiders (*Lampona* spp.), this category includes the black house spiders (*Badumna* spp.) and fiddleback spiders (*Loxosceles rufescens*), an introduced species found around Adelaide, South Australia (Southcott 1976; AVRU 2005b). Bites by these species have been thought to be responsible for a condition termed 'necrotising arachnidism', where the bite site ulcerates and tissue necrotises, but recent research has discounted this for species present in Australia other than *L. rufescens* (Isbister 2004a; Isbister & Gray 2004; Isbister et al. 2005). The age-standardised rate of white-tailed and other necrotising spider bite cases for the 2002–05 study period was 0.5 per 100,000 population.

Only a small proportion (2.9%, n=111) of spider bite cases were attributed to the notorious Sydney funnel web (*Atrax robustus*) and related funnel web spiders (*Hadronyche* spp. and *Atrax* spp.). The age-standardised rate of cases involving these types of spiders was very low, 0.2 per 100,000 population. The distributions of these species are generally limited to the eastern seaboard (Sutherland 1983; AVRU 2005d). The type of spider involved in nearly a third of all spider bite cases was not specified (29.8%, n=1,158).

Table 13: Type of spider attributed to spider bite cases: males, females and persons, Australia 2002–05

External cause	Males	Females	Persons
Contact with funnel web spider	70 (3.3%)	41 (2.3%)	111 (2.9%)
Contact with redback spider	1,259 (59.5%)	1,018 (57.5%)	2,277 (58.6%)
Contact with white-tailed and other necrotising spider	119 (5.6%)	163 (9.2%)	282 (7.3%)
Contact with other specified spider	29 (1.4%)	30 (1.7%)	59 (1.5%)
Contact with unspecified spider	640 (30.2%)	518 (29.3%)	1,158 (29.8%)
Total	**2,117**	**1,770**	**3,887**

Source: Image courtesy AVRU.

Figure 27: Distribution of the redback spider, *Latrodectus hasselti*

Source: Image courtesy AVRU.

Figure 28: Distribution of funnel web spiders, *Atrax* spp. and *Hadronyche* spp.

3.2 Principal diagnosis for spider bites

Three-quarters of all spider bite cases in the period 1st July 2002 to 30th June 2005 had a principal diagnosis of T63.3, venom of spider (75.5% n=2,936). A small proportion of the remaining cases (2.2%, n=87) were coded to a different T63 subcategory (e.g. T63.4, venom of other arthropods, n=35). Other spider bite cases had a principal diagnosis from elsewhere in the ICD-10-AM's injury and poisoning chapter (6.2%, n=241) and principal diagnoses indicating injuries to the wrist and hand were common (n=56).

Most of the spider bite incident cases that did not have a principal diagnosis of T63.3 had a principal diagnosis from outside of the ICD-10-AM's injury and poisoning chapter (16.0% of all spider bite cases, n=623). These principal diagnoses represented a broad spectrum of disease codes, but three types of diagnoses were particularly common: L02, cutaneous abscess, furuncle and carbuncle (11.1% of disease diagnoses, n=69); L03, cellulitis (45.9%, n=286); and L97, ulcer of lower limb, not elsewhere classified (6.9%, n=43). These diagnoses probably refer to infections, necrosis or other complications of bite-sites.

A much larger proportion of cases attributed to white-tailed and other necrotising spiders had a principal diagnosis from outside of the injury and poisoning chapter of the ICD-10-AM (Figure 29). A third of all white-tailed spider bite cases (33.0%, n=93) had a principal diagnosis from Chapter XII, diseases of the skin and subcutaneous tissue (chiefly the L-codes mentioned above). These were also common principal diagnoses for bites from unspecified spiders (25.9% of all cases involving unspecified spiders, n=300). The frequency of these diagnoses may be due to a mistaken attribution of spider bite as the cause of the skin condition, the theory that white-tailed spider bites cause necrotising arachnidism having been debunked only recently (Isbister 2004a; Isbister & Gray 2004; Isbister et al. 2005). Most bite cases attributed to funnel web spiders (91.0%) and redback spiders (91.5%) had a principal diagnosis of T63.3.

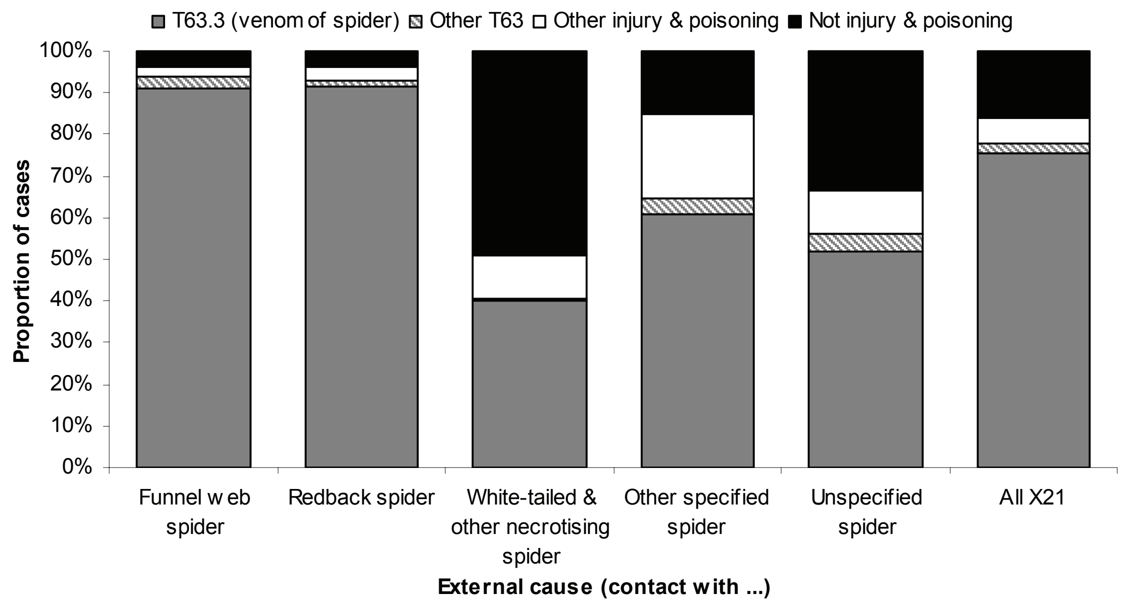


Figure 29: Principal diagnosis for different types of spider bite cases (X21), Australia 2002–05

3.3 Place and activity for spider bites

Three in ten hospitalised spider bite cases in 2002–05 took place in and around the home (32.2%, n=1,250. Table 14). A higher proportion of bites involving funnel web spiders occurred in the home (55.0%, n=61) while only 19.1% (n=54) of bites attributed to white-tailed and other necrotising spiders occurred here. This finding is at odds with Isbister's (2002) research, which presents that white-tailed spider bites characteristically occur indoors, typically bedrooms and bathrooms.

The majority of spider bite incident separations, however, had a recorded place of occurrence of 'unspecified place' (57.6%, n=2,237). Cases involving white-tailed and other necrotising spiders had the highest proportion of records with an unspecified place of occurrence (75.2% of white-tailed spider cases, n=212), which may explain the mismatch of this data with that of Isbister (2002).

Table 14: Place of occurrence for hospitalised cases involving contact with spiders (X21): males, females and persons, Australia 2002–05

Place of occurrence	Males	Females	Persons
Home	599 (28.3%)	651 (36.8%)	1,250 (32.2%)
Residential institution	7 (0.3%)	6 (0.3%)	13 (0.3%)
School	17 (0.8%)	21 (1.2%)	38 (1.0%)
Health service area	* (0.2%)	* (0.8%)	19 (0.5%)
Other specified institution & public administrative area	* (0.2%)	* (0.1%)	5 (0.1%)
Sports & athletics area	8 (0.4%)	7 (0.4%)	15 (0.4%)
Street & highway	* (0.5%)	* (0.2%)	14 (0.4%)
Trade & service area	25 (1.2%)	11 (0.6%)	36 (0.9%)
Industrial & construction area	39 (1.8%)	6 (0.3%)	45 (1.2%)
Farm	41 (1.9%)	10 (0.6%)	51 (1.3%)
Other specified place of occurrence	95 (4.5%)	58 (3.3%)	153 (3.9%)
Unspecified place of occurrence	1,260 (59.5%)	977 (55.2%)	2,237 (57.6%)
Place not reported/not applicable	* (0.4%)	* (0.2%)	11 (0.3%)
Total	**2,117**	**1,770**	**3,887**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

Not surprisingly, given the large proportion of unspecified places of occurrence, most spider bite cases 1st July 2002 to 30th June 2005 reported an unspecified activity code (65.4%, n=2,544. Table 15). A further 11.7%of spider bite cases had 'other specified activity' recorded (n=454). Consistent with many hospitalised spider bites occurring in and around the home, 8.6% of spider bite cases occurred while the person was engaged in other types of work (n=334). As observed for snakebite cases, more males than females experienced a spider bite that resulted in hospitalisation while working for income (163 vs. 37 respectively).

Table 15: Recorded activity for hospitalised cases involving contact with spiders (X21): males, females and persons, Australia 2002–05

Activity	Males	Females	Persons
While engaged in sports	19 (0.9%)	8 (0.5%)	27 (0.7%)
While engaged in leisure	30 (1.4%)	25 (1.4%)	55 (1.4%)
While working for income	163 (7.7%)	37 (2.1%)	200 (5.1%)
While engaged in other types of work	163 (7.7%)	171 (9.7%)	334 (8.6%)
While resting, sleeping, eating, etc.	117 (5.5%)	134 (7.6%)	251 (6.5%)
Other specified activity	240 (11.3%)	214 (12.1%)	454 (11.7%)
Unspecified activity	1,373 (64.9%)	1,171 (66.2%)	2,544 (65.4%)
Activity not reported	12 (0.6%)	10 (0.6%)	22 (0.6%)
Total	**2,117**	**1,770**	**3,887**

3.4 Length of stay for spider bites

As for other types of venomous bites and stings, cases attributed to contact with spiders in the three-year study period had a short mean length of stay (1.8 days ± 3.3 SD). Mean lengths of stay were shortest for cases involving funnel web spiders (1.1 ± 0.5 SD) and longest for white-tailed and other necrotising spiders (4.0 days ± 6.0 SD, Figure 30). Long lengths of stay for white-tailed spiders are correlated with the high frequency of diseases of the skin as principal diagnoses for cases attributed to this type of bite, as observed above. The short lengths of stay associated with funnel web and redback spider bites may be due to the availability of anti-venoms for these specific types of spiders (White 2001).

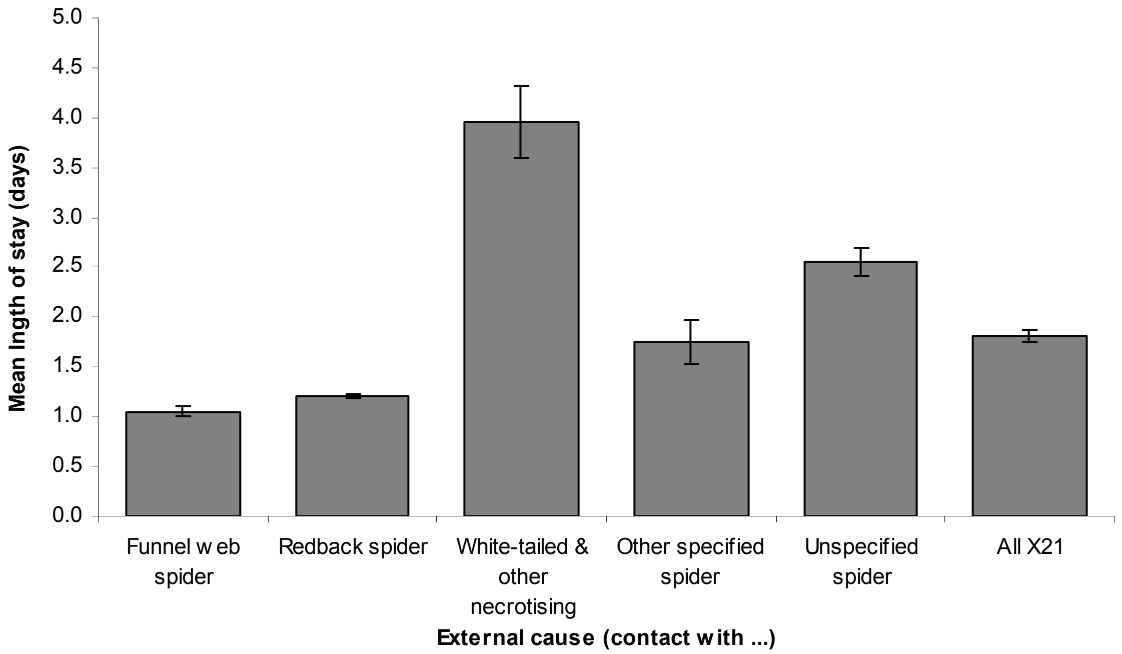


Figure 30: Mean length of stay (days ± SE) for hospitalised spider bite cases (X21), Australia, 2002–05

3.5 Trends in rates of hospitalised spider bites

Venomous bite and sting cases with a first external cause of X21 (spiders) were analysed for the period 1st July 1999 to 30th June 2005. The annual age-standardised rates of hospitalised spider bite cases did not present a consistent pattern over time (Figure 35).

While the highest rates were observed for the year 1999–00 (persons: 7.1 per 100,000 population) and lower rates were observed in the year 2004–05 (persons: 6.2 per 100,000), the width of the confidence intervals suggest that there has not been a significant decline in rates of hospitalised spider bites, the most common type of bite and sting incident, over the six-year study period.

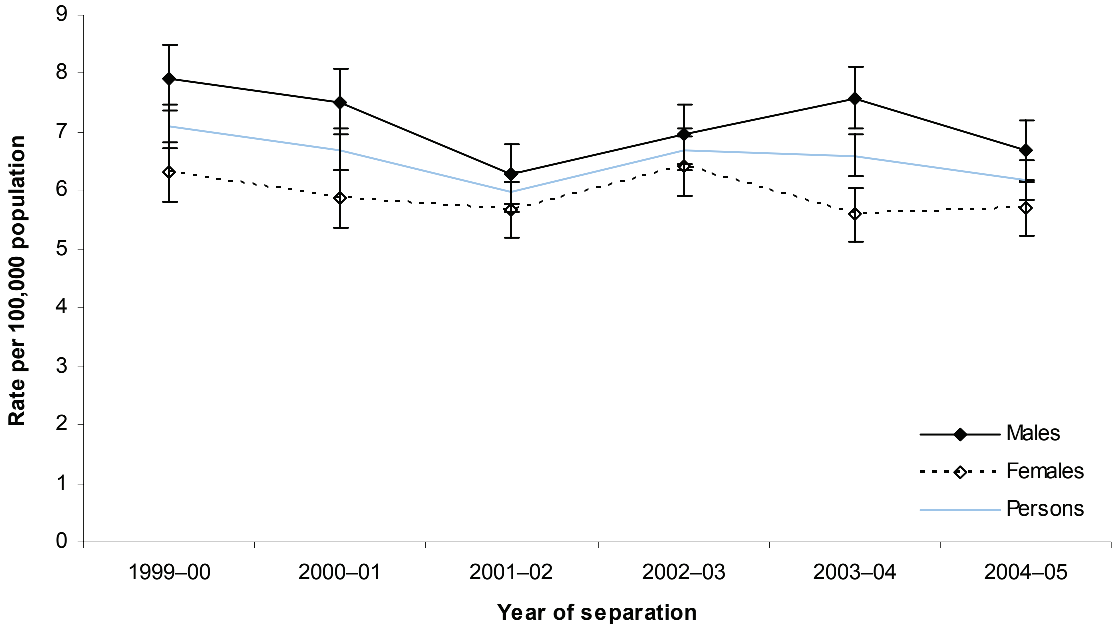


Figure 31: Age-standardised rates (± 95% CI) for all hospitalised cases with a first external cause of X21 over time: males, females and persons, Australia 1999–05

Annual age-standardised rates of hospitalised spider bite cases, unlike other types of bites and stings, did not widely differ from state to state (Figure 32 and Figure 33). Nevertheless, residents of the Northern Territory generally had the highest annual rates of hospitalised spider bites (8.1—12.6 per 100,000 population) while residents of the ACT generally had the lowest rates (0.9—3.6 per 100,000 population). Age-standardised rates of hospitalised spider bite cases were also quite low for residents of Victoria and Tasmania. While venomous spiders, including the redback spider responsible for most spider bite cases, are widespread throughout the country, these analyses indicate that serious spider bites are more common in the warmer states of Australia.

As seen nationally, the rates of spider bites over time were generally stable for each state and territory over the six year study period. The one exception to this appears to be for residents of Queensland, where rates of hospitalised spider bite cases appear to have declined over time (Figure 32).

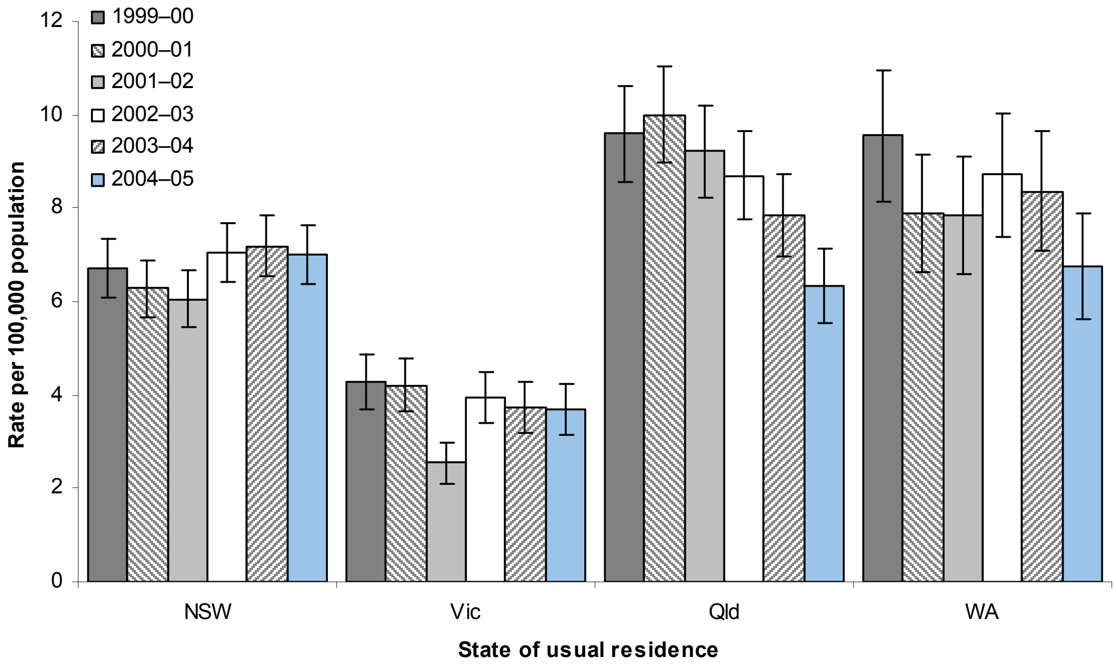


Figure 32: Age-standardised rates (± 95% CI) over time for cases with a first external cause of X21: persons by state of usual residence; New South Wales, Victoria, Queensland and Western Australia, 1999–05

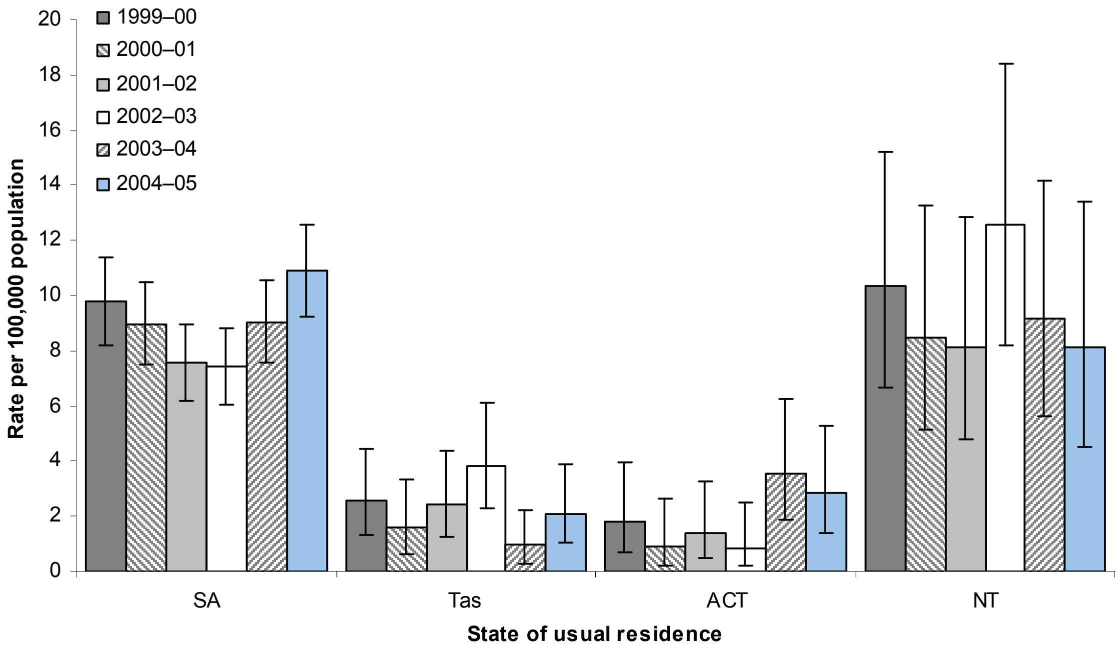


Figure 33: Age-standardised rates (± 95% CI) for cases with a first external cause of X21 over time: persons by state of usual residence; South Australia, Tasmania, ACT and Northern Territory, 1999–05

As for most other types of bites and stings, for each year of this analysis the age-standardised rate of hospitalised spider bites was lowest for residents of Australia's major cities and highest for residents of Australia's remote and very remote regions (Figure 34). Rates of hospitalised spider bite cases remained stable throughout the 2000–05 period for residents of major cities, the highest observed rate being 4.1 per 100,000 in 2002–03 and the lowest being 3.7 per 100,000 in 2004–05. A slight decreasing trend in rates of spider bites was observed for residents of Australia's inner regional areas, but the width of the confidence intervals suggest that this is not significant. Conversely, rates of spider bites appeared to increase over the 2000–05 study period for residents of outer regional areas, however the width of the confidence intervals again suggest that this increase is not significant. Age-standardised rates of hospitalised spider bite cases were generally high for residents of remote and very remote regions, but were variable from year to year. The wide confidence intervals, due to small case numbers (n<100 in each year), indicate that the apparent declines in rates between 2000–01 and 2004–05 are not significant.

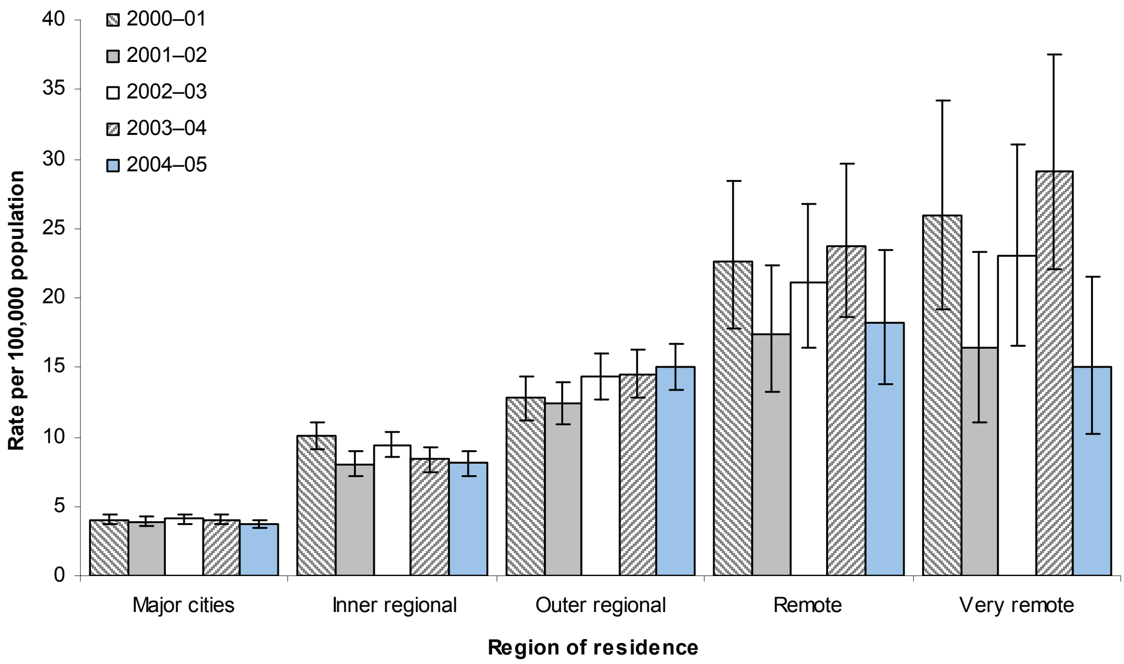


Figure 34: Age-standardised rates (± 95% CI) for cases with a first external cause of X21 over time: persons by remoteness of usual residence, 2000–05

4 Wasps and bees

Contact with hornets, wasps and bees (X23) was the second most common type of venomous bite and sting for cases separating from hospital between 1st July 2002 and 30th June 2005. The 3,557 incident cases involving hornets, wasps and bees represent nearly a third of all hospitalised cases involving venomous animals and plants in this period (30.7%). The majority of these cases were due to bees (n=2,754, 77.4%) and wasps (n=793, 22.3%). Only ten cases in the study period (0.3%) were explicitly attributed to hornets. This small number is not surprising, given that these insects are not thought to be present in Australia south of the Torres Strait (AVRU 2005f).

4.1 Cases attributed to wasps

The average number of hospitalised venomous bite and sting cases with a principal external cause of X23.2 (contact with wasps) in the period 1st July 2002 and 30th June 2005 was 264.3 per year. The age-standardised rate of wasp sting cases in the study period was 1.3 per 100,000 population. Nearly two-thirds of hospitalised wasp stings involved males (62.3%, n=494) and, accordingly, males had a higher rate of wasp stings (1.7 per 100,000) than females (1.0 per 100,000). Age-specific rates of hospitalised wasp sting cases showed different patterns for males and females; rates were generally highest for males aged 10–44 years while rates were highest for older adult females between the ages of 55–69 years (Figure 35). Rates of wasp stings involving males were significantly higher than those involving females between the ages of 10–24 years.

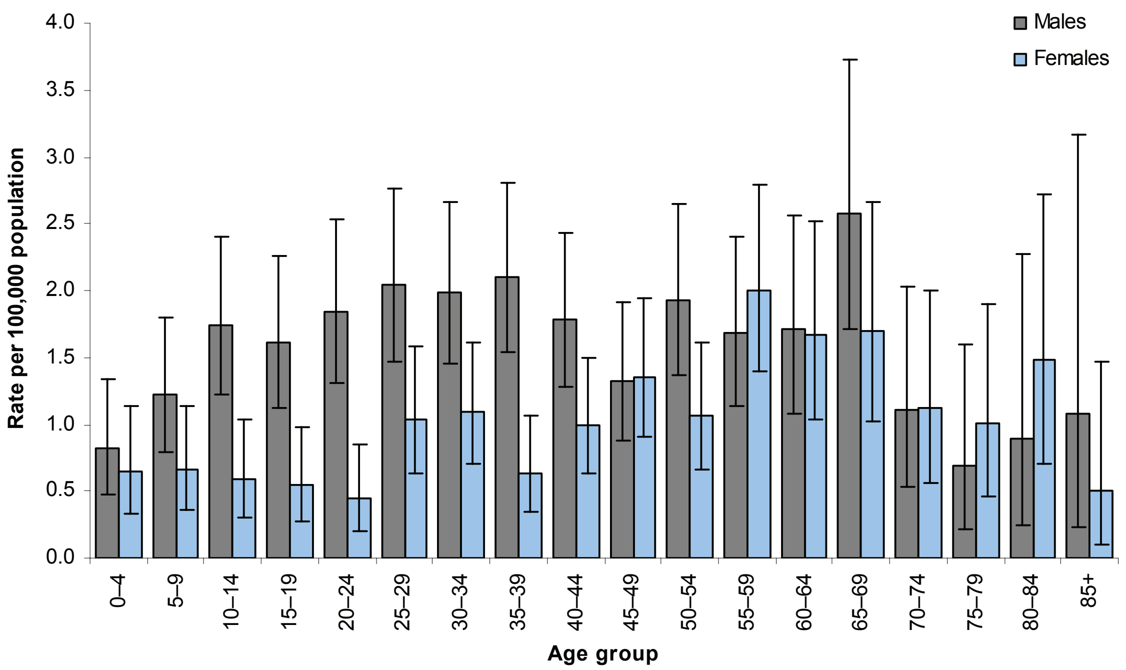


Figure 35: Age-specific rates (± 95% CI) for hospitalised wasp sting cases (X23.2): males and females, Australia 2002–05

4.1.1 Place and activity for wasp stings

The different age-patterns for wasp sting cases involving males and females may be correlated with the places in which wasp stings occurred and/or the activities being undertaken at the time of the incident. As for most other types of venomous bites and stings, the most common specified place of occurrence was the home (25.5%, n=202). A higher proportion of wasp stings involving females occurred in and around the home (29.4% vs. 23.1% of cases involving males) while a higher proportion of wasp sting cases involving males occurred on farms (2.6% vs. 0.7% of cases involving females). Similarly, a higher proportion of females were stung while engaged in 'other types of work' (commonly domestic chores—9.4%, n=28) than males (4.3%, n=23) while a far higher proportion of males were stung by wasps while working for income (9.1%, n=45) than females (2.0%, n=6). Even so, research has suggested that males are more prone to being stung by wasps than females, even when engaged in the same activity (Notman & Beggs 1993).

As for other types of bites and stings, a very large proportion of wasp sting cases reported an unspecified place of occurrence and/or an unspecified activity at the time of the incident (unspecified place: 65.4%, n=519; unspecified activity: 72.1%, n=572).

4.1.2 Principal diagnosis for wasp stings

Nearly two-thirds of wasp sting cases reported a principal diagnosis of T63.4, venom of other arthropods (64.2%, n=509). Only a very small proportion of wasp sting cases reported a different T63 principal diagnosis (e.g. T63.9, toxic effect of contact with unspecified venomous animal: 0.6%, n=5). A fifth of hospitalised wasp sting cases had principal diagnoses from elsewhere in the ICD-10-AM's injury and poisoning chapter (21.4%, n=170), most of which were codes denoting 'other and unspecified effects of external causes' (T66—T78. 83.5% of injury and poisoning diagnoses other than T63, n=142). For these cases, principal diagnoses of T78.2 (anaphylactic shock, unspecified) and T78.4 (allergy, unspecified) were most frequent.

Similar to other types of venomous bites and stings, a proportion of wasp sting cases had a principal diagnosis from outside the ICD-10-AM's injury and poisoning chapter (13.7%, n=109). As seen previously, many of these records reported principal diagnoses from Chapter XII, diseases of the skin and subcutaneous tissue. L03 (cellulitis) diagnoses accounted for about half of these cases (45.0%, n=49) and L50 (urticaria) diagnoses were also common (14.7%, n=16).

4.1.3 Cases by type of wasp, 2004–05

In the fourth edition of the ICD-10-AM (applicable to hospitalisations from 1st July 2004), external cause coding relating to wasps was expanded to include categories describing the particular species of wasps for which the episode of care was attributed (NCCH 2004). Nonetheless, of the 272 wasp sting cases separating from hospital in the period 1st July 2004 to 30th June 2005, the vast majority of cases were attributed to unspecified wasps (81.3%, n=221. Table 16).

Paper wasps (*Polistes* spp. and *Ropalidia* spp.) were described as having caused one in eight hospitalised wasp stings (12.5%, n=34) and yellow jacket wasps (*Vespula* spp. including the introduced European, *V. germanica*, and English, *V. vulgaris*, wasps) were responsible for only eight cases in the study year (2.9%). No cases were attributed to mud wasps and only nine cases were attributed to other specified wasp species (which may include native flower wasps of the families Scoliidae, Tiphiidae and Mutillidae).

The proportions of cases attributed to the different types of wasps were generally similar for both males and females, with only slightly lower proportions of cases attributed to contact with unspecified wasps for females.

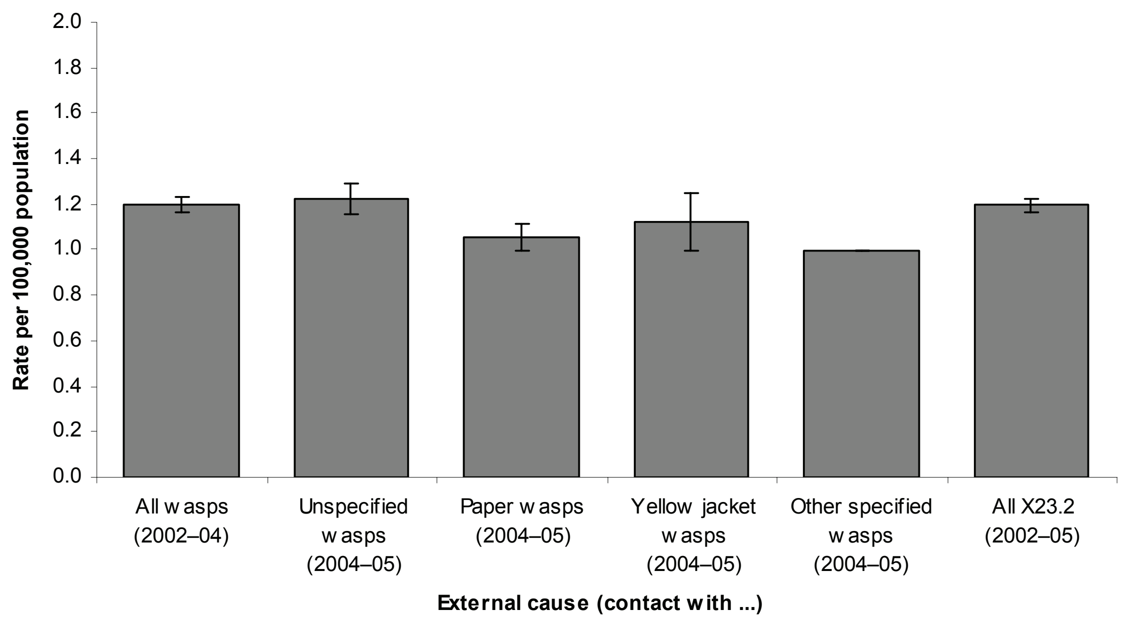
Table 16: Type of wasp attributed to hospitalised cases: males, females and persons, Australia 2004–05

External cause	Males	Females	Persons
Contact with unspecified wasps	135 (82.8%)	86 (78.9%)	221 (81.3%)
Contact with paper wasps	22 (13.5%)	12 (11.0%)	34 (12.5%)
Contact with yellow jacket wasps	*	*	8 (2.9%)
Contact with mud wasps	0 (0.0%)	0 (0.0%)	0 (0.0%)
Contact with other specified wasps	*	*	9 (3.3%)
Total	**163**	**109**	**272**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

4.1.4 Length of stay for wasp stings

The overall mean length of stay for hospitalised wasp sting cases was short: 1.2 days ± 0.9 SD. Mean lengths of stay did not appear to differ significantly with the specific type of wasp involved in the incident where this data was available (Figure 36), but it must be remembered that most of the hospitalised wasp cases in 2004–05 (81.3%) were coded as unspecified types of wasp.



*** Note that category means have been calculated for different data years due to changes to the ICD-10-AM X23 coding.**

Figure 36: Mean length of stay (days ± SE) for hospitalised wasp sting cases (X23.2), Australia 2002–05*

4.2 Cases attributed to bees

Contact with bees (X23.3) accounted for most of the X23 cases (77.4%) and nearly a quarter of *all* hospitalised venomous bite and sting cases (23.7%) in the period 1st July 2002 to 30th June 2005 (n=2,754). The average annual number of cases involving bees which resulted in hospitalisation was 918 per year.

The age-standardised rate of bee sting cases was 4.6 per 100,000 population. Nearly three-quarters of all hospitalised bee sting cases involved males (73.1%, n=2,013), resulting in a much higher age-standardised rate for males (6.7 per 100,000) than for females (2.5 per 100,000); a M:F rate ratio of 2.7 to 1. Higher rates of bee stings for Australian males have been reported previously (e.g. Harvey et al. 1984; Roberts-Thomson et al. 1985).

Age-specific rates were significantly higher for males than for females for all age groups except for Australians aged 75 years and older (Figure 37). The highest rate of hospitalised bee sting cases was in the 5–9 year age group for both sexes. At this age, males were hospitalised at a rate of 12.5 cases per 100,000 population, while females were hospitalised at a rate of 4.8 cases per 100,000 population (a M:F rate ratio of 2.6: to 1). The greatest difference in rates for males and females was observed for the 40–44 years age group, where the rate for males was 4.6 times higher than that of females.

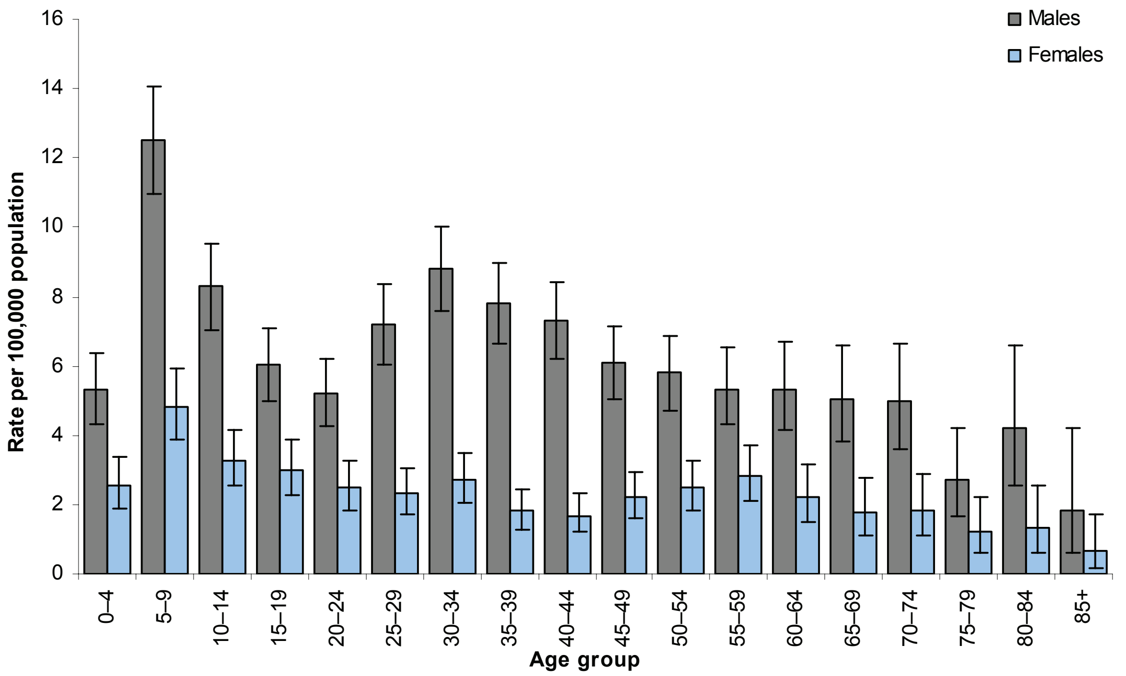


Figure 37: Age-specific rates (± 95% CI) for hospitalised bee sting cases (X23.3): males and females, Australia 2002–05

4.2.1 Place and activity for bee stings

As for wasp stings, and other types of venomous bite and sting cases, the place of occurrence reported for the majority of bee sting cases was unspecified (74.8%, n=2,061. See Table 17). The most common *specified* place of occurrence for bee sting cases was the home and surrounds (14.2%, n=391). A higher proportion of females were stung by bees in the home (16.1%) than males (13.5%). Conversely, a higher proportion of males than females were stung by bees in the street, in trade and industrial areas and on farms. These observations tally with a higher proportion of males being stung by bees while working for income (6.2% vs. 0.8% for females, see Table 18). The activity at the time of the sting was unspecified for more than three-quarters of all hospitalised bee sting cases (77.1%, n=2,124).

Table 17: Place of occurrence for hospitalised bee sting cases (X23.3): males, females and persons, Australia 2002–05

Place of occurrence	Males	Females	Persons
Home	272 (13.5%)	119 (16.1%)	391 (14.2%)
School	20 (1.0%)	12 (1.6%)	32 (1.2%)
Health service area	9 (0.4%)	7 (0.9%)	16 (0.6%)
Sports & athletics area	23 (1.1%)	6 (0.8%)	29 (1.1%)
Street & highway	52 (2.6%)	11 (1.5%)	63 (2.3%)
Trade & service area	11 (0.5%)	0 (0.0%)	11 (0.4%)
Industrial & construction area	12 (0.6%)	0 (0.0%)	12 (0.4%)
Farm	37 (1.8%)	5 (0.7%)	42 (1.5%)
Other specified place of occurrence	70 (3.5%)	24 (3.2%)	94 (3.4%)
Unspecified place of occurrence	1,504 (74.7%)	557 (75.2%)	2,061 (74.8%)
Total *	**2,013**	**741**	**2,754**

* Totals include 1 case which occurred in an 'other specified institution and public administrative area' and 2 cases for which place of occurrence was not reported.

Table 18: Activity codes for hospitalised bee sting cases (X23.3): males, females and persons, Australia 2002–05

Activity	Males	Females	Persons
While engaged in sports	41 (2.0%)	10 (1.3%)	51 (1.9%)
While engaged in leisure	19 (0.9%)	11 (1.5%)	30 (1.1%)
While working for income	125 (6.2%)	6 (0.8%)	131 (4.8%)
While engaged in other types of work	47 (2.3%)	29 (3.9%)	76 (2.8%)
While resting, sleeping, eating, etc.	21 (1.0%)	10 (1.3%)	31 (1.1%)
Other specified activity	225 (11.2%)	73 (9.9%)	298 (10.8%)
Unspecified activity	1,527 (75.9%)	597 (80.6%)	2,124 (77.1%)
Activity not reported/not applicable	8 (0.4%)	5 (0.7%)	13 (0.5%)
Total	**2,013**	**741**	**2,754**

4.2.2 Principal diagnosis for bee stings

Most of the hospitalised cases attributed to bee stings in the period 1st July 2002 to 30th June 2005 had a principal diagnosis of T63.4, venom of other arthropods (71.8%, n=1,977). This was a higher proportion of cases than for those attributed to wasps. Like wasp sting cases, a very small proportion of bee sting cases had a different T63 subcategory as the principal diagnosis (0.6%, n=16). A lower proportion of bee sting cases than wasp stings was coded with principal diagnoses from elsewhere in the ICD-10-AM's injury and poisoning chapter (14.7%, n=406), most commonly T78.2 (anaphylactic shock, unspecified, n=184) and T78.4 (allergy, unspecified, n=152).

As for wasp stings and other types of venomous bites and stings, some bee sting cases had a principal diagnosis from outside the ICD-10-AM's injury and poisoning chapter (12.9%, n=355). Again, many of these records reported principal diagnoses of L03 (cellulitis: 41.1%, n=146) and L50 (urticaria: 18.6%, n=66).

4.2.3 Cases by type of bee, 2004–05

The fourth edition of the ICD-10-AM contains fifth-character codes to describe the particular type of bee involved in an X23.3 external cause episode (NCCH 2004). A total of 923 bee sting cases were identified for the one year of the study period coded to this edition of the ICD-10-AM (1st July 2004 to 30th June 2005). Of these, surprisingly few were coded as being due to contact with introduced honey bees, *Apis mellifera* (2.7%, n=25. Table 19). Allergy to *Apis* spp. stings is common and can be fatal in some cases (Harvey et al. 1984; Riches et al. 2002; AVRU 2005e). Native bees, on the other hand, are considered less dangerous; some species are stingless (e.g. *Trigona* spp.) and while others possess stings (e.g. *Lasioglossum* spp., *Amegilla* spp. and *Xylocopa* spp.), their stings are generally smaller than those of honey bees and these species are considered to be less aggressive than honey bees (Sutherland 1983; Australian Native Bee Research Centre 1997-2005; Australian Museum 2003). Nevertheless, some native bee species have been attributed to hospitalisations and at least one fatality (Morris et al. 1988). Six bee stings resulting in hospitalisation between 1st July 2002 and 30th June 2005 were recorded as being due to native bees.

Bumblebees (*Bombus terrestris*) are also capable of inducing potentially-fatal analphylaxis and, while more docile than honeybees, are able to sting multiple times (AVRU 2005a; Lamb & Dollin 2005). Bumblebee populations in Australia are currently limited to Tasmania (having been introduced in the 1990s). Nevertheless, 6 of the 10 cases recorded as due to contact with bumblebees involved Victorian residents hospitalised in Victoria while only one incident separated from a Tasmanian hospital during the study period.

Despite the greatest bee-related threat to Australians being due to contact with honey bees (Riches et al. 2002), the overwhelming majority of cases was coded as contact with unspecified bees (93.5%, n=863). It may be that most people assume that all bee stings are due to contact with introduced honey bees and as such, there is no need to explicitly state this to medical professionals or in the case documentation.

A further 2.1% of cases were coded as due to contact with other specified bees, but with categories covering honey, bumble and native bees, it is unknown as to what species this refers.

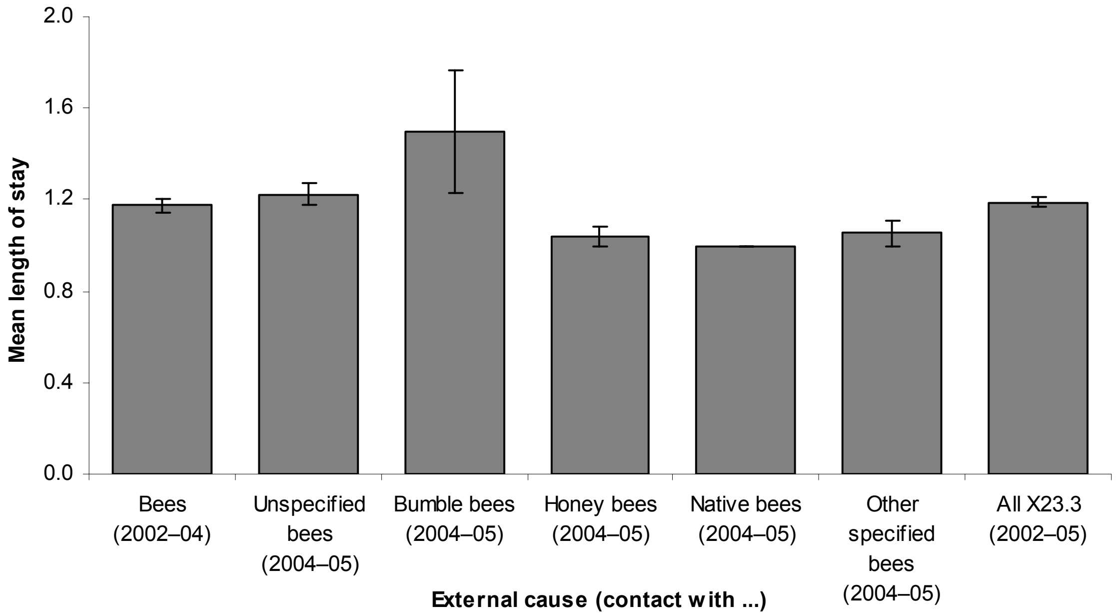
Table 19: Type of bee attributed to hospitalised cases: males, females and persons, Australia 2004–05

External cause	Males	Females	Persons
Contact with unspecified bees	635 (93.8%)	228 (92.7%)	863 (93.5%)
Contact with bumble bees	5 (0.7%)	5 (2.0%)	10 (1.1%)
Contact with honey bees	18 (2.7%)	7 (2.8%)	25 (2.7%)
Contact with native bees	* (0.4%)	* (1.2%)	6 (0.7%)
Contact with other specified bees	* (2.4%)	* (1.2%)	19 (2.1%)
Total	**677**	**246**	**923**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

4.2.4 Length of stay for bee stings

The overall mean length of stay for hospitalised bee sting cases was short, and very similar to that for wasp stings: 1.2 days ± 1.3 SD. Mean lengths of stay did not appear to significantly differ according to the type of bee involved in the incident where this data was available (Figure 38). However, as for wasp stings, it must be remembered that nearly all hospitalised bee sting cases in 2004–05 (93.5%) were coded as unspecified types of bee.



*** Note that category means have been calculated for different data years due to changes to the ICD-10-AM X23 coding.**

Figure 38: Mean length of stay (days ± SE) for hospitalised bee sting cases (X23.3), Australia 2002–05*

4.3 Trends in rates of hospitalised wasp and bee stings

In the first year of the national usage of the ICD-10-AM (1999–00, ICD-10-AM first edition), cases involving hornets, wasps or bees could not be separately identified. As such, analysis of age-standardised rates over time between 1st July 1999 and 30th June 2005 incorporates all such stings (X23). Little change in the rate of hospitalised wasp and bee stings occurred over the study period (Figure 39). While males had a much higher rate of hospitalised stings, the pattern of rates over time was very similar for both males and females.

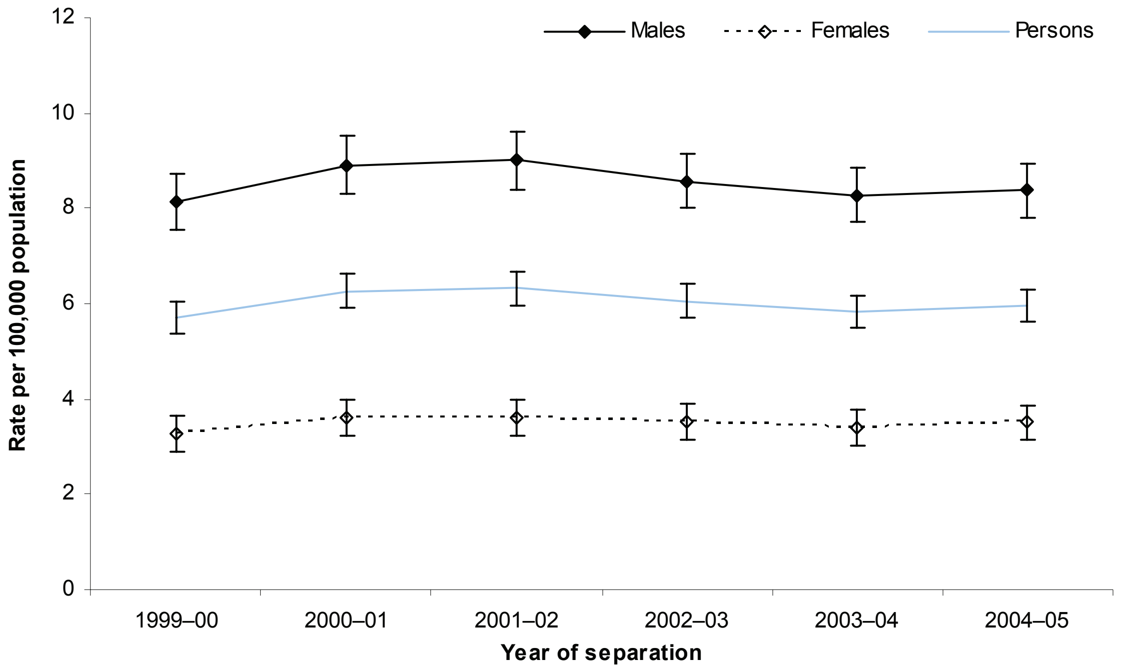


Figure 39: Age-standardised rates (± 95% CI) for all hospitalised cases attributed to hornets, wasps or bees (X23): males, females and persons, Australia 1999–05

From the second edition of the ICD-10-AM onwards (period beginning 1st July 2000), cases involving hornets, wasps and bees could be separately identified. Between 1st July 2000 and 30th June 2005, an annual average of 5.4 hospitalised cases were attributed to hornet stings (total n=27). Specific analysis was not undertaken for this small number of cases.

Figure 40 presents the age-standardised rates for persons per 100,000 population for hospitalised wasp and bee sting cases for the five year period 1st July 2000 to 30th June 2005. While no significant decline in either rate is noted for this period, it is interesting to observe that when the rate of bee stings was higher, the rate of wasp sting cases was lower and vice versa. The reasons for this are unknown, but might be the result of environmental conditions influencing population abundance (Drake 1997; Oldroyd et al. 1997).

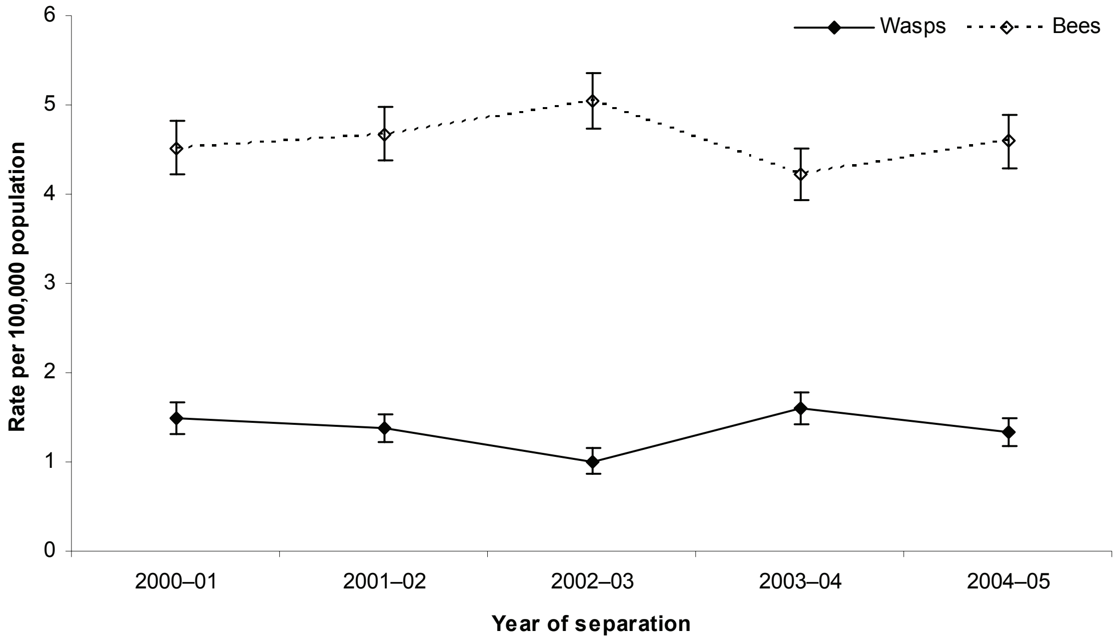


Figure 40: Age-standardised rates (± 95% CI) for hospitalised cases attributed to wasps (X23.2) or bees (X23.3): Australia, 2000–05

Table 20: Age-standardised rates (± 95% CI) of hospitalised wasp and bee sting cases by state of usual residence, Australia 2000–05

	State of usual residence	2000–01	2001–02	2002–03	2003–04	2004–05
Wasps	**NSW**	0.8	1.1	0.5	1.0	1.1
	Vic	0.7	0.6	0.3	1.0	0.8
	Qld	5.2	3.8	3.2	4.5	3.5
	WA	0.4	0.6	0.9	0.5	0.4
	SA	0.4	0.5	0.4	1.1	0.5
	Tas	0.6	0.4	0.6	0.4	0.4
	ACT	0.3	0.0	0.0	0.0	0.0
	NT	0.0	0.4	0.5	0.0	0.0
Bees	**NSW**	3.5	4.4	4.4	3.7	3.6
	Vic	2.5	3.1	3.6	3.2	3.7
	Qld	2.9	2.4	3.0	2.1	2.9
	WA	8.9	7.3	9.8	8.4	9.4
	SA	15.4	14.4	13.1	12.2	12.0
	Tas	2.8	3.3	2.3	1.7	0.9
	ACT	1.0	4.4	5.1	0.0	2.7
	NT	0.6	0.4	0.8	0.4	0.4

Note: Shading indicates the state which had the highest rates of hospitalised wasp or bee stings over the study period.

Wasp stings and bee stings appear to have a very different pattern of occurrence according to the person's state of usual residence (Table 20). In all the years analysed, the age-standardised rate of wasp sting cases was far higher for residents of Queensland (range: 3.2–5.2 per 100,000 population) than for residents of the other Australian states and territories. This was somewhat surprising given that the aggressive European wasp *Vespula germanica* does not yet have a widespread presence in Queensland (CSIRO Entomology 2006) and the distributions of native wasp species capable of serious stings are not restricted to this state (e.g. Sutherland 1983; CSIRO Entomology 2005; e.g. Saito & Kojima 2005). Nevertheless, it has previously been observed that Queenslanders have a high prevalence of sensitivity to *Polistes* and *Ropalidia* spp. stings (Solley 1990) and that most recorded wasp sting deaths have also involved residents of Queensland (McGain et al. 2000).

The lowest rates of cases involving wasp stings involved residents of the ACT (with no cases in most years) and, unlike many other types of venomous bites and stings, residents of the Northern Territory (where the highest rate observed was only 0.5 per 100,000 population). All states other than Queensland reported rates of hospitalised wasp sting cases of less than 1.2 per 100,000 population in each year of the study.

As can be seen in Table 20, the state-specific rates of hospitalised bee stings present a very different pattern to those for wasp sting cases. The highest age-standardised rates of bee sting cases involved residents of South Australia and these rates were much higher than those for most of the rest of the country, despite various species of venomous bees, including the introduced honeybee, being nationally widespread (Oldroyd et al. 1997). Rates for residents of South Australia in the period 2000–05 ranged between 12.0 and 15.4 per 100,000 population. The lowest rates of hospitalised bee stings again involved residents of the Northern Territory and the ACT. Age-standardised rates of hospitalised bee stings for residents of the other states of Australia were generally higher than those for wasp sting cases, but were below 4.5 per 100,000 population in all years except for residents of Western Australia. In Western Australia, rates fluctuated between 7.3 per 100,000 and 9.8 per 100,000 during the five-year study period.

As for all X23 cases nationally, the rate of wasp and bee sting cases in any of Australia's states and territories appeared to remain relatively constant throughout the 2000–05 study period (Table 20). In the two states for which residents recorded the highest rates of wasp stings (Queensland) and bees stings (South Australia), rates of these types of cases appeared to decrease slightly over the five-year study period (Figure 41). Nevertheless, for wasp stings involving residents of Queensland this decrease was not consistent from year to year and the width of the confidence intervals indicates that this was not a significant decline. Similarly, while the rate of bee sting cases involving residents of South Australia declined steadily in each successive year of the study period, the decrease also appears to be insignificant.

These findings are further discussed in Chapter 8 (page 97).

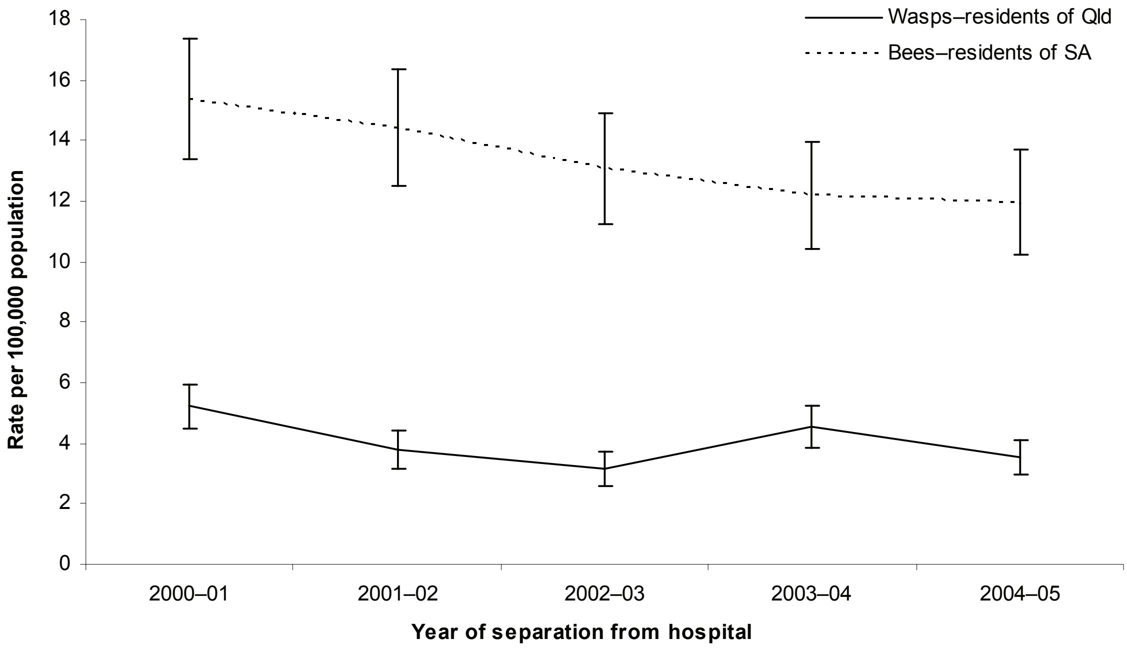


Figure 41: Age-standardised rates (± 95% CI) for cases with an external cause of X23.2 (wasps) for residents of Queensland and X23.3 (bees) for residents of South Australia, 2000–05

The age-standardised rates of wasp and bee sting cases also exhibited somewhat different patterns according to the remoteness of the persons' usual residence. For cases attributed to wasps, annual rates were generally highest for people resident in Australia's remote regions (Figure 42). The width of the confidence intervals suggest that there is not a significant difference in rates according to remoteness of residence other than between residents of major cities and residents of other regions in each year and analysis of the rate of wasp stings by remoteness of usual residence for the entire five year study period supports this. Similarly, the width of the confidence intervals suggest that there was not any significant changes in the rates of each region across the 2000–05 study period, despite apparent large declines in later years of the study in remote and very remote regions.

For cases attributed to bees there is a more distinct difference in the age-standardised rates involving residents of Australia's major cities, inner regional, and outer regional areas (Figure 43, note figures to different scales). This pattern was consistent for all years analysed and for the entire five year study period when analysed as a whole. While rates of hospitalised bee sting cases involving residents of remote regions were high, these were not significantly different to the rates for residents of outer regional areas. The rates of hospitalised bee sting cases involving residents of very remote regions, however, were much lower than those for outer regional and remote areas. While the wide confidence intervals provoked by small case numbers suggest that these rates are not significantly different to those for most other areas for single data years, the rate calculated for this zone for the entire five year period confirms that residents of Australia's very remote regions have a significantly lower rate of hospitalised bee stings.

As for hospitalised wasp stings, the rate of hospitalised bee sting cases does not appear to have significantly changed over time for any of the remoteness regions analysed.

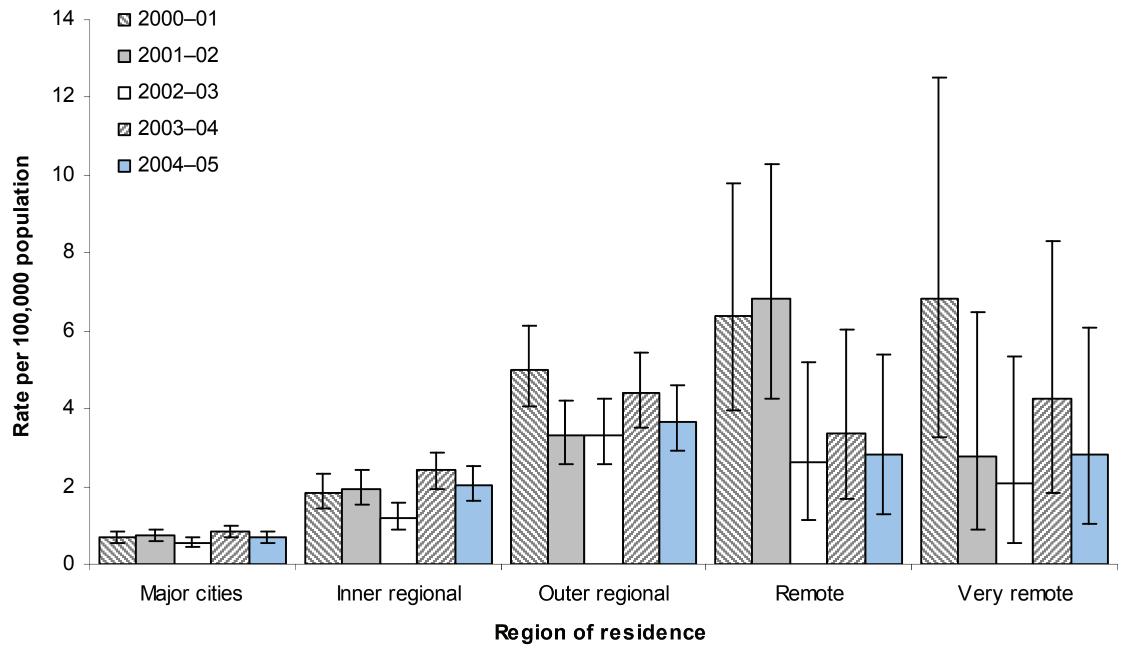


Figure 42: Age-standardised rates (± 95% CI) over time for cases with a first external cause of X23.2 (wasps) by region of usual residence, Australia 2000–05

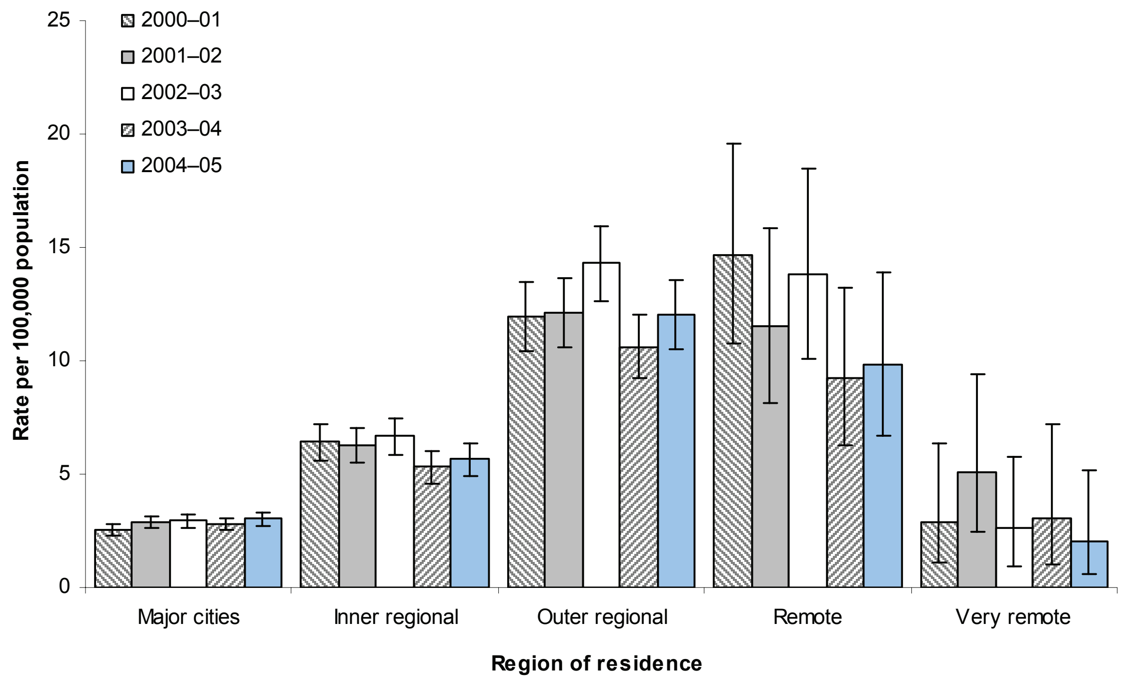


Figure 43: Age-standardised rates (± 95% CI) over time for cases with a first external cause of X23.3 (bees) by region of usual residence, Australia 2000–05

5 Ants and other arthropods

The ICD-10-AM code X25 denotes contact with venomous ants, ticks and other venomous arthropods. In the period 1st July 2002 to 30th June 2005, 1,127 hospital separations had a principal external cause code of X25 and a mode of admission other than transfer from another acute hospital. These cases most frequently involved contact with venomous ticks (43.2%, n=487), followed by contact with venomous ants (30.8%, n=347). Contact with venomous and urticating caterpillars (which have venomous or irritating hairs) resulted in 13 hospitalised cases during the study period (1.2%) and a further 280 cases were attributed to other or unspecified venomous arthropods (24.8%).

5.1 Contact with venomous ants

The ICD-10-AM code X25.0 denotes contact with venomous ants. In the period 1st July 2002 to 30th June 2005, 347 venomous bite and sting cases were coded with a principal diagnosis of X25.0, an annual average of 115.7 cases per year. The age-standardised rate of hospitalised ant stings was 0.6 per 100,000 population. Unlike many other types of venomous bites and stings, the rate of hospitalised ant stings was the same for both males and females; an age-standardised rate of 0.6 per 100,000 for both sexes. The general pattern of age-specific rates were somewhat different for males and females however; rates of hospitalised ant sting cases were highest for young males, specifically the 0–14 years age groups, while rates for females were highest for older adults, specifically the 55–64 years group (Figure 44).

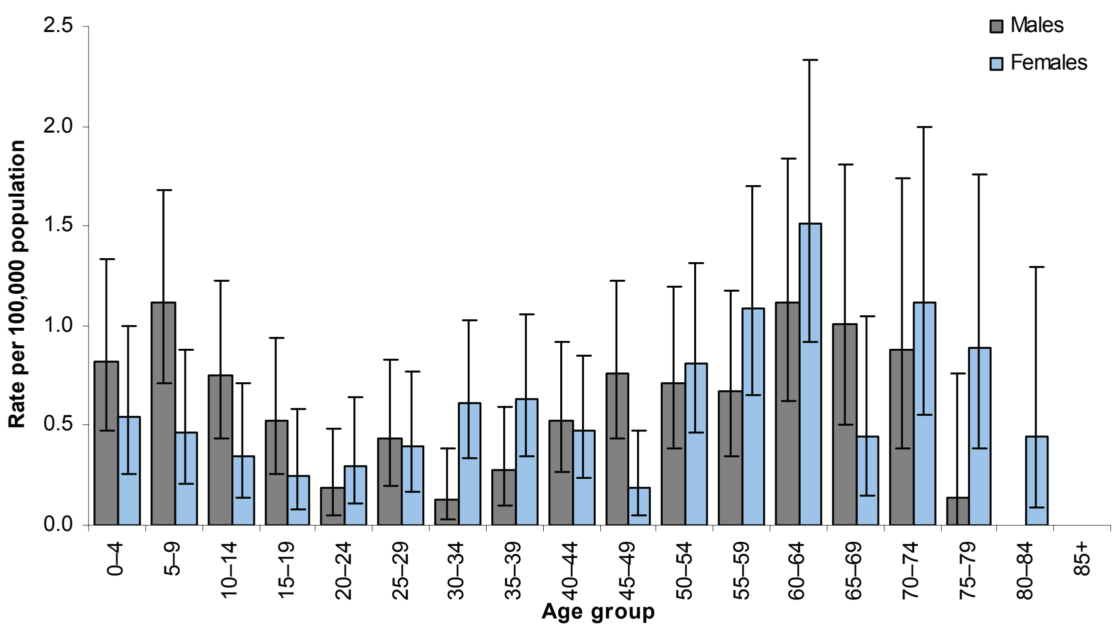


Figure 44: Age-specific rates (± 95% CI) for hospitalised cases attributed to contact with ants (X25.0): males and females, Australia 2002–05

5.1.1 Cases by type of ants

The third edition of the ICD-10-AM onwards includes subcategory coding describing the particular type of ant attributed to the episode of hospital care. Most hospitalised cases involving ants involved jack jumper (or hopper) and bulldog ants, *Myrmecia* spp. (60.8%, n=211. Table 21). While these species are widespread throughout Australia, high rates of allergy, particularly to jack jumper ants (*Myrmecia pilosula*), have been detected in the Tasmanian population (Brown et al. 2003). Most known ant-related fatalities have also occurred in this state (Brown et al. 2001; McGain & Winkel 2002). While the largest *number* of jack jumper ant stings involved residents of Victoria (37.5%, n=80), over a quarter of all jumper ant-related cases were sustained by residents of Tasmania (26.5%, n=56), far in excess of the relative size of the state's population.

A small proportion of cases involving ants were attributed to green (tree) ants (*Oecophylla smaragdina*: 11.0%, n=38). These ants, also called weaver ants, are found in the northern parts of Australia (Lokkers 1986) and, not surprisingly, the majority of these cases were sustained by residents of Queensland (73.7%, n=28). Just under one-third of hospitalised cases involving ants were coded as due to other or unspecified ant species (28.2%, n=98). No hospitalisations were attributed to the introduced fire ant, *Solenopsis invicta*, which has recently become established in the Brisbane area (Solley et al. 2002; AVRU 2005c).

Table 21: Type of ant attributed to ant sting cases (X25.0): males, females and persons, Australia 2002–05

External cause	Males	Females	Persons
Contact with jumper and bull ant	110 (62.1%)	101 (59.4%)	211 (60.8%)
Contact with fire ant	0 (0.0%)	0 (0.0%)	0 (0.0%)
Contact with green ant	17 (9.6%)	21 (12.4%)	38 (11.0%)
Other specified venomous ant	13 (7.3%)	9 (5.3%)	22 (6.3%)
Contact with venomous ant, unspecified	37 (20.9%)	39 (22.9%)	76 (21.9%)
Total	**177**	**170**	**347**

5.1.2 Principal diagnosis for ant stings

Nearly two-thirds of ant sting cases (62.0%, n=215) separating from hospital in the period 1st July 2002 to 30th June 2005 were coded with a principal diagnosis T63.4 (venom of other arthropods). A small proportion of ant sting cases had a principal diagnosis of another T63 code (0.6%, n=2). More than a fifth of all ant sting cases had a principal diagnosis from elsewhere in the ICD-10-AM's injury and poisoning chapter (22.2%, n=77). As for other types of insect sting cases, most of these (77.9%, n=60) were T78 codes indicating anaphylactic shock and allergy, unspecified. The remaining proportion of ant sting cases were not coded with an injury principal diagnosis (15.3%, n=53). Again, many of these were Chapter XII codes, diseases of the skin and subcutaneous tissue (67.9%, n=36).

As can be seen in Figure 45, slightly higher proportions of cases involving 'other specified' venomous ants and unspecified venomous ants were coded with T63.4 as the principal diagnosis than for stings by other types of ant. Conversely, a higher proportion of jumper and bull ant and green ant stings reported injury and poisoning principal diagnoses other than T63. As observed above, these codes were predominately T78 codes indicating anaphylactic shock and allergy, unspecified. A relatively high proportion of cases attributed to green ants had a principal diagnosis from outside of the ICD-10-AM's injury and poisoning chapter (and as observed above, these were chiefly skin-condition codes).

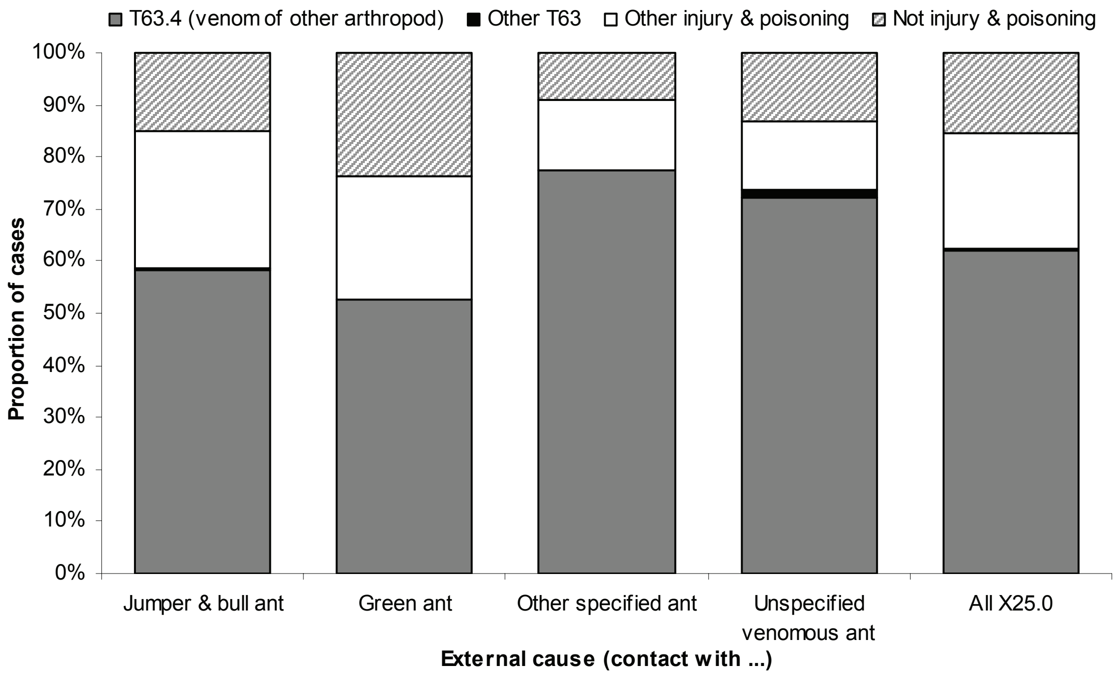


Figure 45: Principal diagnosis for different types of ant sting cases (X25.0), Australia 2002–05

5.1.3 Place and activity for ant sting cases

A pattern similar to that reported for other types of bites and stings was observed for cases involving ants: approximately one-third of cases occurred in the home (31.7%, n=110) while for a majority of cases (58.2%, n=202), place of occurrence was unspecified. Due to the small numbers, place of occurrence cannot be reported for the remaining 35 cases.

Similarly, and as for most hospitalised venomous bites and stings, the activity being undertaken at the time of an ant sting was frequently unspecified (68.9%, n=239). One in ten ant sting cases occurred while the person was engaged in 'other types of work' (11.8%, n=41), consistent with the large proportion of cases taking place in and around the home.

5.1.4 Length of stay for ant sting cases

As for other types of venomous bites and stings, cases attributed to contact with venomous ants in the 2002–05 study period had a short mean length of stay (1.2 days ± 1.3 SD). Mean lengths of stay were generally similar for all types of ant stings (Figure 46). Stings involving jumper and bull ants had a slightly longer mean length of stay (1.3 days ± 1.6 SD) than other types of ant stings, but this was an insignificant difference. Ant stings involving males had a somewhat longer, and more variable, mean length of stay (1.3 days ± 1.8 SD) than cases involving females (1.1 ± 0.4 SD).

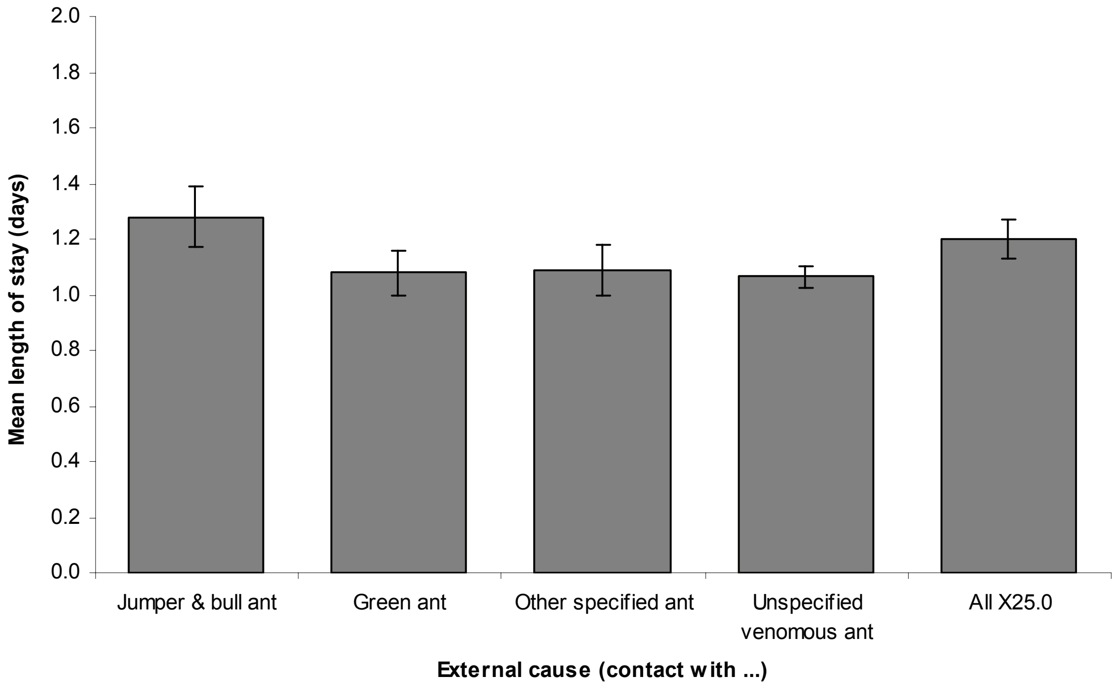


Figure 46: Mean length of stay (days ± SE) for hospitalised ant sting cases (X25.0), Australia 2002–05

5.2 Contact with venomous ticks

The Australian paralysis tick (*Ixodes holocyus*) is widely distributed along the eastern seaboard (Figure 47) and its bite is capable of provoking severe reactions, including paralysis and anaphylaxis, and transmitting serious zoonotic diseases (e.g. spotted fever, Sutherland 1983; Beckmann 1989). While there are many species of ticks in Australia, *Ixodes holocyus* is considered to be the most medically significant to humans (Storer et al. 2003; Doggett 2004), however *Ixodes cornuatus*, the Tasmanian paralysis tick has also been implicated in at least one envenomation (Tibballs & Cooper 1986). The ICD-10-AM does not contain codes which differentiate between tick species involved in hospitalisations and the anti-venom developed primarily for *Ixodes holocyus* bites is thought to be effective for bites from other species of the genus (White 2001).

A total of 487 cases attributed to tick bites (X25.1) separated from hospital in the period 1st July 2002 and 30th June 2005, an annual average of 162.3 cases per year. The age-standardised rate of hospitalised tick bite cases over this period was 0.8 per 100,000 population). Males had a slightly higher rate of serious tick bites (0.9 per 100,000) than females (0.7 per 100,000). Age-specific rates of hospitalised cases due to tick bites showed a similar pattern for both males and females except in the oldest age groups (Figure 48). Rates were highest for young children (0–9 years) and lowest for teenagers and young adults (15–34 years).

Source: Image courtesy AVRU.

Figure 47: Distribution of the Australian paralysis tick, *Ixodes holocyus*

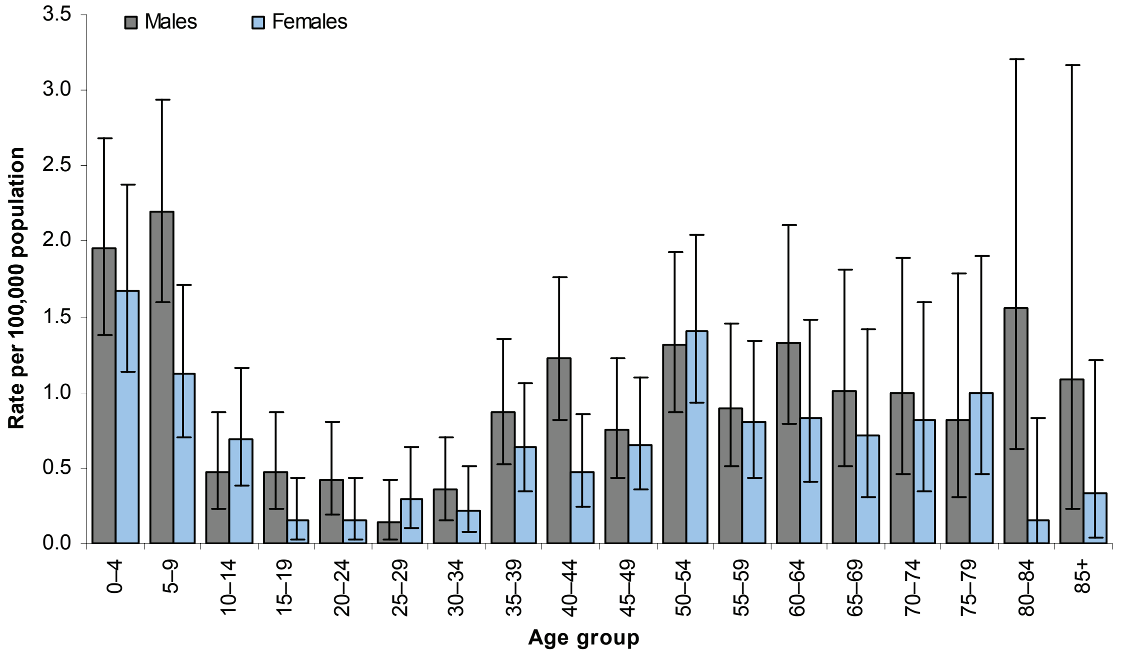


Figure 48: Age-specific rates (± 95% CI) for hospitalised tick bite cases (X25.1): males and females, Australia 2002–05

Very high proportion of cases were coded with an unspecified place of occurrence (73.1%, n=356) and/or an unspecified activity (84.8%, n=413). As with other types of venomous bites and stings, a reasonable proportion of tick bite cases occurred in and around the home (17.5%, n=85). A small proportion of hospitalised tick bites occurred near streams, large bodies of water and forests (2.5%, n=12), which was a lower proportion than expected given that typical habitat for *Ixodes holocyus* is wet sclerophyll forests and temperate rainforests and this species is commonly referred to as the 'scrub tick' (Beckmann 1989). A small proportion of tick bite cases occurred while the person was engaged in sport and leisure activities (4.7%, n=23) and few tick bite cases occurred working for income (1.2%, n=6) or while engaged in other types of work (2.9%, n=14).

The mean length of stay observed for tick bite cases separating from hospital in the period 1st July 2002 to 30th June 2005 was slightly longer than many other types of venomous bites and stings; 2.1 days (± 4.7 SD).

5.2.1 Principal diagnosis for tick bites

A lower proportion of tick bite cases reported the most relevant T63 sub-code as the principal diagnosis (T63.4, venom of other arthropods. 56.5%, n=275) than observed for other types of venomous bites and stings. Conversely, a larger proportion of hospitalised tick bite cases had a principal diagnosis from the ICD-10-AM's injury and poisoning chapter, other than T63 (14.6%, n=71). Most frequently, these were the T78 codes commonly reported for other types of insect bites and stings, indicating anaphylactic shock and allergy (42.3%, n=30). Unlike other types of venomous bites and stings, principal diagnoses indicating injuries to the head were also relatively common (23.9% of injury and poisoning diagnoses other than T63, n=17).

Nearly a third of tick bite cases were assigned a principal diagnosis code from outside of the ICD-10-AM's injury and poisoning chapter (26.9% of all tick bite cases, n=131). As observed for other types of bites and stings, diagnosis codes from ICD-10-AM Chapter XII (diseases of the skin and subcutaneous tissue) were very common (52.7% of non-injury diagnoses, n=69). Codes from Chapter XVIII (symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified) were also relatively frequent (15.3%, n=20).

5.3 Trends in rates of hospitalised cases due to ants and other arthropods

For most of the period in which the ICD-10-AM has been used to code hospital separations, bites and stings attributed to ants, ticks and other venomous arthropods could not be isolated from each other (e.g. NCCH 2000). As such, trends analysis has been performed here using the entire X25 category.

All bite and sting incident cases with a first external cause of X25 were analysed for the period 1st July 1999 to 30th June 2005 (Figure 49). While varying throughout the study period, annual age-standardised rates for both males and persons overall were observed to have significantly increased when the first year (1999–00) and the last year (2004–05) of the study period were compared. Rates for females did not significantly differ however.

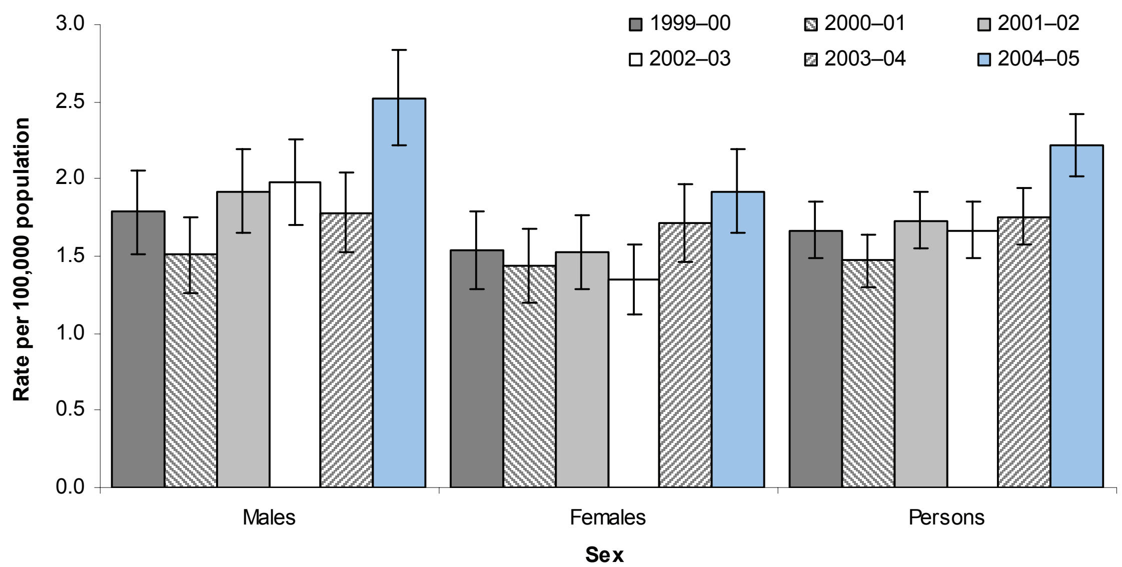


Figure 49: Age-standardised rates (± 95% CI) for hospitalised cases attributed to X25 (ants and other arthropods) over time: males, females and persons, Australia 1999–05

Age-standardised rates of hospitalised cases coded to X25 (ants and other arthropods) varied considerably according to the person's state of usual residence (Figures 50 and 51, note that figures are on the same scale). Of the eastern seaboard states, residents of Queensland and New South Wales had relatively high rates of venomous bites and stings attributed to X25 (Figure 50). Venomous ant species and venomous tick species are both common in these states (Storer et al. 2003), but only residents of New South Wales, most likely due to this state's large population, reported more than 100 such cases in every year. Rates of X25 cases for residents of the two cooler-climate eastern states, the ACT and Victoria, were generally lower than for Queensland and New South Wales, but the wide confidence intervals suggest that this is not a significant difference. While the Australian paralysis tick, *Ixoides holocyclus*, is not present in the ACT, both the ACT and Victoria have relatively large *Myrmecia* spp. populations (Douglas et al. 1998), the genus most commonly attributed to the ant stings that required hospitalisation in 2002–05.

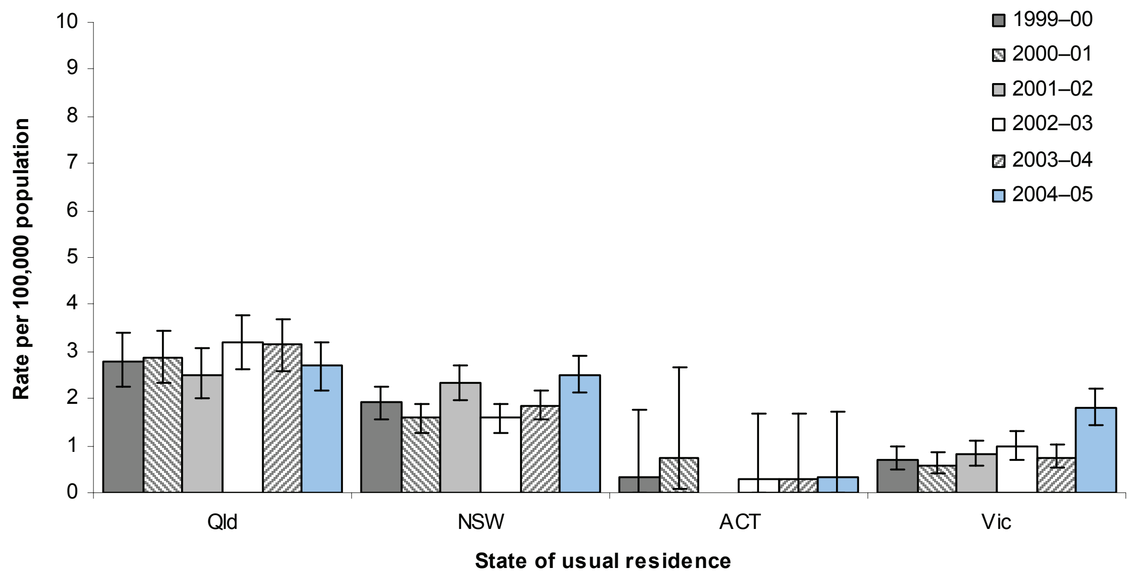


Figure 50: Age-standardised rates (± 95% CI) of X25 cases over time by state of usual residence: the eastern seaboard states; Queensland, New South Wales, the ACT and Victoria, 1999–05

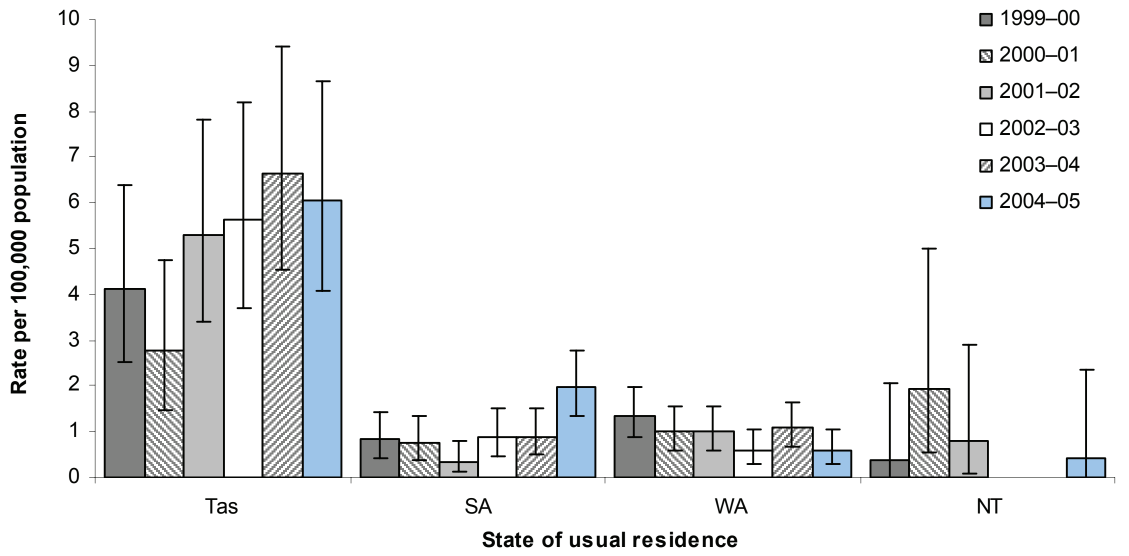


Figure 51: Age-standardised rates (± 95% CI) of X25 cases over time by state of usual residence: the other states of Australia; Tasmania, South Australia, Western Australia and the Northern Territory, 1999–05

The highest rates of hospitalised X25 cases involved residents of Tasmania (Figure 51). While the paralysis tick *Ixodes cornuatus* is present in Tasmania, most X25 cases involving residents of Tasmania are thought to be due to stings from jack jumper ants (*Myrmecia pilosula*). While this species is widespread throughout Australia, a high prevalence of allergy, particularly to jack jumper ant stings, has been detected in the Tasmanian population and most known ant-related fatalities have also occurred in this state (McGain & Winkel 2002; Brown et al. 2003).

As can be seen in Figures 50 and 51, despite some annual fluctuation the rate of hospitalised X25 cases have been generally stable over the period analysed.

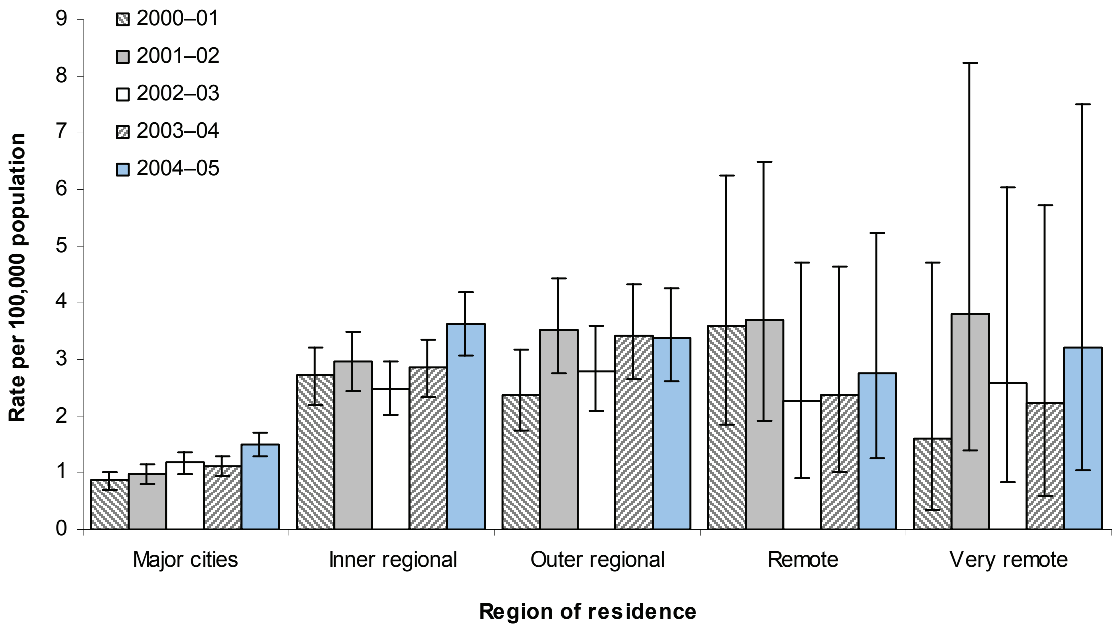


Figure 52: Age-standardised rates (± 95% CI) of X25 cases by region of usual residence, Australia 2000–05

Less variation was present in the rate of hospitalised X25 cases according to the remoteness of the person's usual residence than for other types of venomous bites and stings. Nonetheless, as observed for other types of bites and stings, the age-standardised rate of X25 cases was lowest for residents of Australia's major cities (Figure 52) and rates involving residents of Australia's inner regional areas were significantly higher than those for major cities in all of the years in the analysis. Rates of X25 cases involving residents of more remote regions (outer regional, remote and very remote areas), however, were very similar to those for residents of Australia's inner regional areas in all years. Analysis of X25 cases for the entire five-year study period confirms that differences in the rates of hospitalisation involving residents of inner regional, outer regional, remote and very remote areas are insignificant.

Rates of hospitalised cases coded to X25 do not appear to have made any significant changes over time for most of the regions analysed. There does, however, appear to have been a significant increase in the rate of venomous arthropod stings involving residents of Australia's major cities over the five-year study period. This could be due to population expansion into suburban fringe areas where arthropods capable of serious stings are known to reside (e.g. the Adelaide Hills, South Australia. See Sutherland 1983; Brown et al. 2001).

6 Marine animals and plants

Contact with venomous marine animals and plants (X26) was the fifth most common cause of hospitalised venomous bite and sting cases in the period 1st July 2002 and 30th June 2005 (9.0% of cases, n=1,041). The annual average number of hospitalised marine bite and stings was 347.0 cases per year.

The age-standardised rate of hospitalised cases involving venomous marine animals and plants was 1.8 per 100,000 population. Males had a considerably higher rate of marine bites and stings (2.5 per 100,000 population) than females (1.0 per 100,000). High rates of hospitalised marine bites and stings were strongly skewed towards younger ages (Figure 53). The age specific rates of hospitalised marine cases involving males were significantly higher than those for females between the ages of 15–49 years.

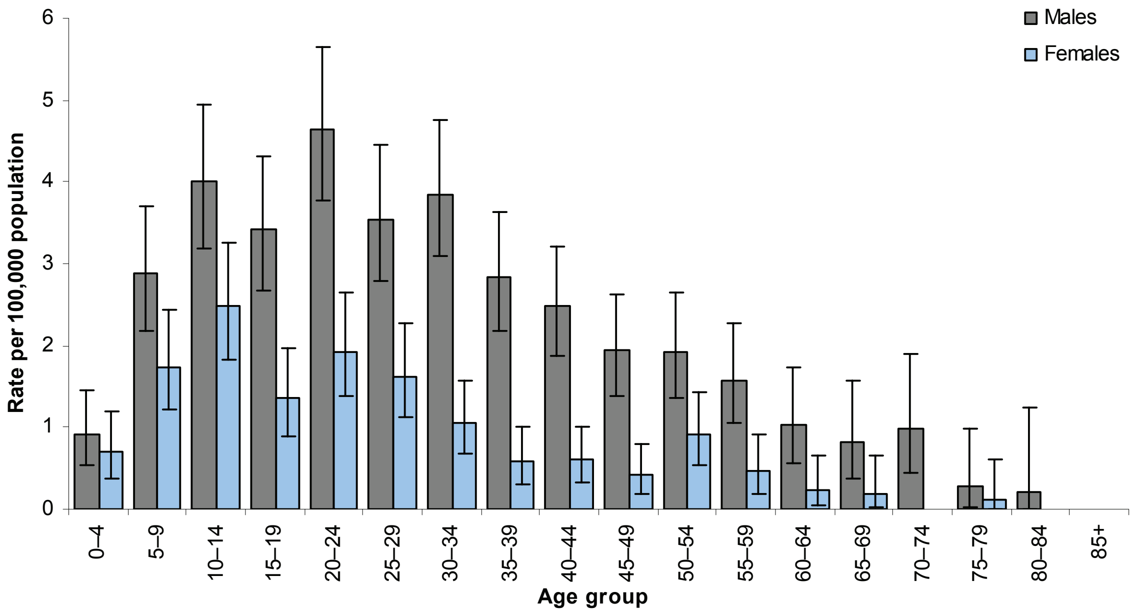


Figure 53: Age-specific rates (± 95% CI) for hospitalised cases involving venomous marine animals and plants (X26): males and females, Australia 2002–05

6.1 Types of venomous marine bites and stings

A third of the hospitalised X26 cases during the study period involved contact with venomous jellyfish (36.0%, n=375). Cases involving contact with stinging fish and stingrays were also common (18.3% and 16.5% of cases coded to X26, respectively. See Table 22).

For females, a higher proportion of hospitalised X26 cases were attributed to jellyfish (46.9%, n=135) than for cases involving males (31.9%, n=240. Table 22). For both sexes, however, Irukandji jellyfish were the most common jellyfish responsible for hospitalisation. The Irukandji jellyfish (*Carukia barnesi*) is seasonally common throughout northern Australian waters (Figure 54). Interestingly, nearly one in five stings by Irukandji jellyfish in 2002–05 (17.9%, n=43) appear to involve an international visitor (these records lack a state of usual residence code and have an overseas country of birth code). The notorious box jellyfish, Portuguese man-o-war (more correctly, Pacific man-o-war) and bluebottle also have a wide distribution throughout northern Australia but were responsible for surprisingly few hospitalised cases in 2002–05 (see Sutherland 1983). The age-standardised rate of hospitalised jellyfish sting cases of all types was 0.6 per 100,000 population. The rate for males was slightly higher (0.8 per 100,000) than that for females (0.5 per 100,000 population).

Table 22: Type of venomous marine animal or plant attributed to X26 incident cases; males, females and persons, Australia 2002–05

External cause	Males	Females	Persons
Contact with box jellyfish	19 (2.5%)	10 (3.5%)	29 (2.8%)
Contact with Irukandji jellyfish	152 (20.2%)	88 (30.6%)	240 (23.1%)
Contact with Portuguese Man-o-war & bluebottle	* (1.9%)	* (3.1%)	* (2.2%)
Contact with other specified jellyfish	* (1.2%)	* (0.3%)	* (1.0%)
Contact with unspecified jellyfish	46 (6.1%)	27 (9.4%)	73 (7.0%)
Subtotal–jellyfish	*240 (31.9%)*	*135 (46.9%)*	*375 (36.0%)*
Contact with stonefish	45 (6.0%)	17 (5.9%)	62 (6.0%)
Contact with other specified stinging fish	97 (12.9%)	31 (10.8%)	128 (12.3%)
Subtotal–stinging fish	*142 (18.9%)*	*48 (16.7%)*	*190 (18.3%)*
Contact with venomous octopus	* (0.3%)	* (0.0%)	* (0.2%)
Contact with stingray	148 (19.7%)	24 (8.3%)	172 (16.5%)
Other specified venomous marine animals & plants	146 (19.4%)	43 (14.9%)	189 (18.2%)
Contact with unspecified venomous marine animals & plants	75 (10.0%)	38 (13.2%)	113 (10.9%)
Total	**753**	**288**	**1,041**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

Stonefish and other stinging fish (of which there are many species in Australian waters) were responsible for 18.3% of all bites and stings involving marine animals and plants (n=190). The age-standardised rate of hospitalised cases due to contact with stinging fish was 0.3 per 100,000 population, and again this rate was higher for males (0.5 per 100,000) than for females (0.2 per 100,000).

Stonefish (*Synanceia* spp. including the highly venomous estuarine stonefish, *Synanceia horrida*, see Nimorakiotakis & Winkel 2003) were responsible for one-third of all stinging fish cases in the three year study period 2002–05 (n=62). Stonefish are thought to be relatively common throughout their wide distribution (Figure 55) but their remarkable camouflage makes it difficult to estimate population size. As has been suggested by other authors (Williamson et al. 1996), the not insignificant number of injuries attributed to stonefish in the study period attest to their common status. Other types of stinging fish include catfish (e.g. *Cnidoglanis macrocephalus*), scorpionfish and lionfish (families Scorpaenidae and Setarchidae), stingerfish (family Syanceiidae), the bullrout (*Notesthes robusta*), the old wife (*Enoplosus armatus*), the cobbler (*Gymnapistes marmoratus*), and Port Jackson sharks (*Heterodontus portusjacksoni*, see Sutherland 1983). Many of these species are common in southern temperate waters, e.g. Figure 56, as well as the more northerly tropical regions (Rifkin & Williamson 1996; Isbister 2001; Museum Victoria 2006). These, and other, venomous fish were implicated in 128 hospitalised cases over the three-year study period.

Australia's venomous octopus species (the blue-ringed octopuses, *Hapalochlaena* spp.) are dangerous and are known to have been responsible for several fatalities (Williamson et al. 1996). Nonetheless, these animals are also known to be quite shy and bites generally only occur if the octopus is handled (Sutherland 1983; Williamson et al. 1996). This non-aggressive nature is suggested by the observation that only two cases involving venomous octopuses were hospitalised in the study period 1st July 2002 to 30th June 2005.

Contact with stingrays was reported as the first external cause for a relatively large number of marine bite and sting cases (16.5%, n=172). Stingray species are found in all Australian marine waters. A much higher proportion of hospitalised stingray cases involved males (19.7%, n=148) than involved females (8.3%, n=24). Accordingly, males had a higher rate of cases involving stingrays (0.5 per 100,000) than females (0.1 per 100,000). A similar number of marine bites and stings were attributed to other specified marine animals and plants (n=189, 18.2% of cases). These cases would include stings from contact with the highly decorative cone shells (*Conus* spp.), stinging corals, sea sponges (Porifera), sea anemones, sea cucumbers and sea urchins. In a tenth of all venomous marine bite and sting cases, the creature involved was not specified (10.9%, n=113).

Source: Image courtesy AVRU.

Figure 54: Australian distribution of the Irukandji jellyfish, *Carukia barnesi*

Source: Image courtesy AVRU.

Figure 55: Distribution of Australian stonefish species, *Synanceia* spp.

Source: Image courtesy AVRU.

Figure 56: Distribution of the cobbler, *Gymnapistes marmoratus*

6.2 Principal diagnosis for marine bites and stings

Half of all cases coded to X26 had T63.6 (toxic effect of other venomous marine animals) recorded as the principal diagnosis (52.8%, n=550. See Figure 57). Almost all incident cases due to jellyfish stings had this code as the principal diagnosis while smaller proportions of T63.6 diagnoses were noted for other types of venomous marine bites and stings. Not surprisingly, T63.5 (toxic effect of contact with fish) was a common principal diagnosis for cases involving stonefish and other stinging fish. T63.5 was also recorded as the principal diagnosis for small proportions of cases involving stingrays and other and unspecified marine animals and plants. Nearly half of cases involving stinging fish, stingrays and other marine animals and plants, and smaller proportions of the other marine categories, reported principal diagnoses from the ICD-10-AM's injury and poisoning chapter other than T63. As expected, many of these separations had codes indicting physical damage to the ankle and foot (41.7% of 'other' injury and poisoning, n=111) and injuries to the wrist and hand (29.3%, n=78).

As for other types of venomous bites and stings, a number of cases involving marine animals and plants reported principal diagnoses from outside the ICD-10-AM's injury and poisoning chapter (12.9% of X26 cases overall, n=134). Again, most of these cases (78.4%, n=105) had principal diagnoses from Chapter XII, diseases of the skin and subcutaneous tissue (frequently L03, cellulitis).

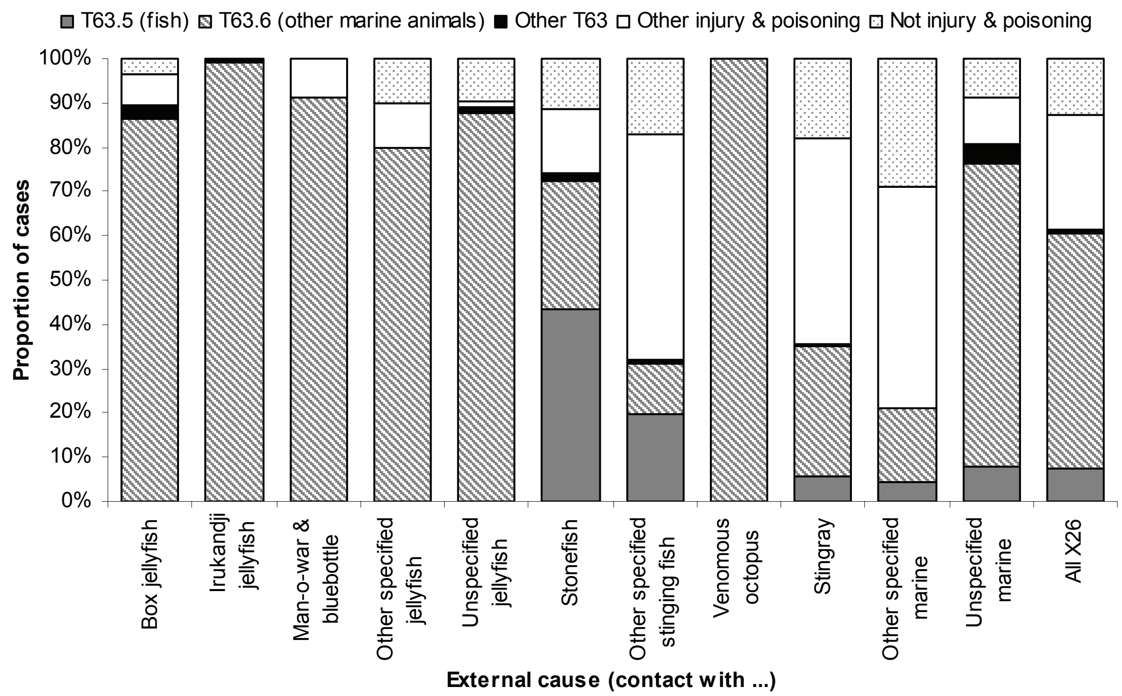


Figure 57: Principal diagnosis for hospitalised cases with first external cause of X26, Australia 2002–05

6.3 Place and activity for marine bites and stings

Unlike other types of venomous bites and stings, only a fifth of cases involving marine animals and plants in the 2002–05 period recorded an unspecified place of occurrence (21.9%, n=228). Further, (and not surprisingly) very few marine bites and stings occurred in the home (0.8%, n=8).

As expected, most cases attributed to venomous marine animals and plants occurred in 'other specified places', chiefly water bodies (Table 23). Two in five marine bites and stings occurred in large areas of water (40.5%, n=455). A further 26.4% (n=275) marine cases occurred on beaches. Streams of water and areas of still water accounted for another 5.5% of cases (n=57). In all, these places accounted for 72.4% of cases attributed to venomous marine animals and plants. Patterns of place of occurrence were similar for both males and females, with only a slightly higher proportion of cases occurring near large areas of water (43.1%) and on beaches (29.5%) for females than for males (39.6% and 25.2% respectively). This may be related to the slightly higher proportion of cases involving females being attributed to contact with jellyfish (dead or beached jellyfish are still capable of inflicting stings, see Australian Museum 2007).

Table 23: Place of occurrence for hospitalised cases attributed to venomous marine animals and plants (X26): males, females and persons Australia 2002–05

Place of occurrence	Males	Females	Persons
Home	* (0.8%)	* (0.7%)	8 (0.8%)
Sports & athletics area	* (0.4%)	* (0.0%)	* (0.3%)
Trade & service area	* (0.4%)	* (1.0%)	6 (0.6%)
Farm	* (0.1%)	* (0.0%)	* (0.1%)
Area of still water	* (0.4%)	* (0.3%)	* (0.4%)
Stream of water	40 (5.3%)	13 (4.5%)	53 (5.1%)
Large area of water	298 (39.6%)	124 (43.1%)	422 (40.5%)
Beach	190 (25.2%)	85 (29.5%)	275 (26.4%)
Other specified place of occurrence	* (2.5%)	* (1.4%)	23 (2.2%)
Unspecified place of occurrence	176 (23.4%)	52 (18.1%)	228 (21.9%)
Place not reported/not applicable	* (1.9%)	* (1.4%)	18 (1.7%)
Total	**753**	**288**	**1,041**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

Not surprisingly, the activities reported for marine bite or sting cases were also somewhat different to those reported for other types of bites and stings (Table 24). A large proportion of marine bites and stings occurred while the person was engaged in sports or leisure activities (41.4%, n=431). Of the 358 cases sustained while engaged in sports activities, nearly all (97.2%, n=348) reported activity codes that explicitly involved water, such as swimming (48.0% of sports activities, n=172) and fishing (27.1%, n=97).

The proportion of marine bites and stings sustained while working for income was similar to that for many other types of bites and stings (5.0%, n=52). As expected, many of these (69.2%, n=36) were sustained while the person was working in the agriculture, forestry and fishing industries and it is assumed that most of these, if not all, would have involved the fishing industry in particular. Related to the small proportion of marine bites and stings that occurred in the home, only a small proportion of cases were sustained while the person was involved in 'other types of work' (0.5%, n=5). Like other types of bites and stings a very large proportion of cases involving venomous marine animals and plants reported 'unspecified activity' for the event (38.8%, n=404). This was somewhat surprising due to both the lower proportion of unspecified place of occurrence reported for marine bites and stings and the large number of specific sports and leisure activity codes available for use.

The reported activity codes for marine bites and stings involving males and females were very similar. As seen for other types of bites and stings, a higher proportion of cases involving males were sustained while working for income than was observed for females.

Table 24: Type of activity for cases involving marine animals or plants (X26): males, females and persons, Australia 2002-05

Activity		Males	Females	Persons
While engaged in sport	Jet skiing	* (0.3%)	* (0.0%)	* (0.2%)
	Unspecified boating sport	* (0.5%)	* (0.3%)	5 (0.5%)
	Diving	* (0.9%)	* (0.3%)	8 (0.8%)
	Fishing	85 (11.3%)	12 (4.2%)	97 (9.3%)
	Scuba diving	12 (1.6%)	5 (1.7%)	17 (1.6%)
	Snorkelling	11 (1.5%)	11 (3.8%)	22 (2.1%)
	Surfing & boogie boarding	* (2.5%)	* (0.7%)	21 (2.0%)
	Swimming	102 (13.5%)	70 (24.3%)	172 (16.5%)
	Water skiing	* (0.1%)	* (0.0%)	* (0.1%)
	Other & unspecified sports activities	* (1.2%)	* (1.4%)	13 (1.2%)
While engaged in leisure		54 (7.2%)	19 (6.6%)	73 (7.0%)
While working for income		46 (6.1%)	6 (2.1%)	52 (5.0%)
While engaged in other types of work		* (0.7%)	* (0.7%)	7 (0.7%)
While resting, sleeping, eating etc		* (0.3%)	* (1.0%)	5 (0.5%)
Other specified activity		95 (12.6%)	47 (16.3%)	142 (13.6%)
Unspecified activity		299 (39.7%)	105 (36.5%)	404 (38.8%)
Total		**753**	**288**	**1,041**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

6.4 Length of stay for marine bites and stings

Cases attributed to contact with venomous marine animals and plants in the 2002–05 study period had a short mean length of stay (1.8 days ± 2.6 SD), similar to other types of venomous bites and stings. Mean lengths of stay were comparable for all types of jellyfish stings while cases involving stonefish and other stinging fish were slightly longer (Figure 58). Cases involving stingrays had a significantly higher mean length of stay (2.7 days ± 5.1 SD) than both jellyfish and stinging fish cases, which may be related to the fact that these events may involve both envenomation and severe penetrating injuries (e.g. Sutherland 1983). Similarly, cases involving other specified marine animals and plants, which include corals, had a relatively long mean length of stay which may indicate significant mechanical injury in addition to possible envenomation for these cases.

Marine bites and stings involving males had a slightly longer mean length of stay (1.9 days ± 2.9 SD) than cases involving females (1.5 ± 1.3 SD). This is most probably due to the greater proportion of cases attributed to stingrays and 'other specified' marine animals and plants that involved males.

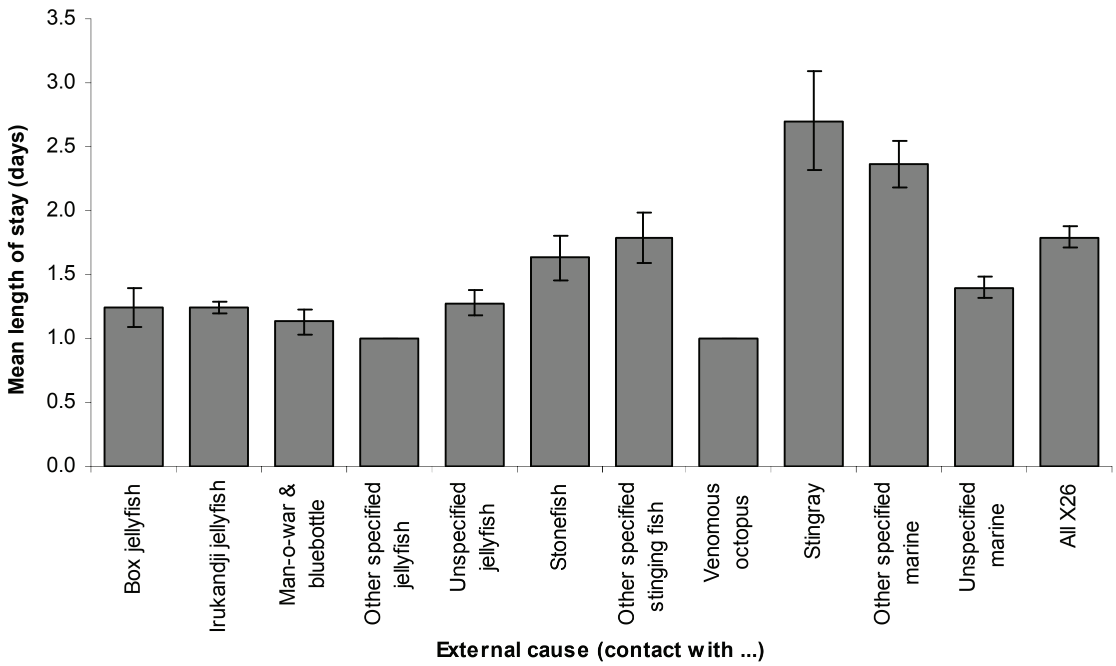


Figure 58: Mean length of stay (days ± SE) for hospitalised marine bite and sting cases (X26), Australia 2002–05

6.5 Trends in rates of hospitalised marine bites and stings

For most of the period in which the ICD-10-AM has been used to code hospital separations, bites and stings attributed to venomous marine animals and plants could not be isolated from each other (e.g. NCCH 2000). As such, trends analysis has only been performed here using the entire X26 category.

Hospitalised cases with a first external cause of X26 were analysed for the period 1st July 1999 to 30th June 2005 (Figure 59). While the rates of hospitalised cases attributed to marine animals and plants were significantly higher for males than for females in all years, incidence for both males and females markedly peaked in the 2001–02 year and then returned to levels similar to those seen in the first years of the analysis. This is thought to be primarily due to natural population fluctuations of venomous marine creatures in this year, chiefly affecting rates of cases involving residents of Queensland (see Figure 60) and/or residents of outer regional areas (Figure 62).

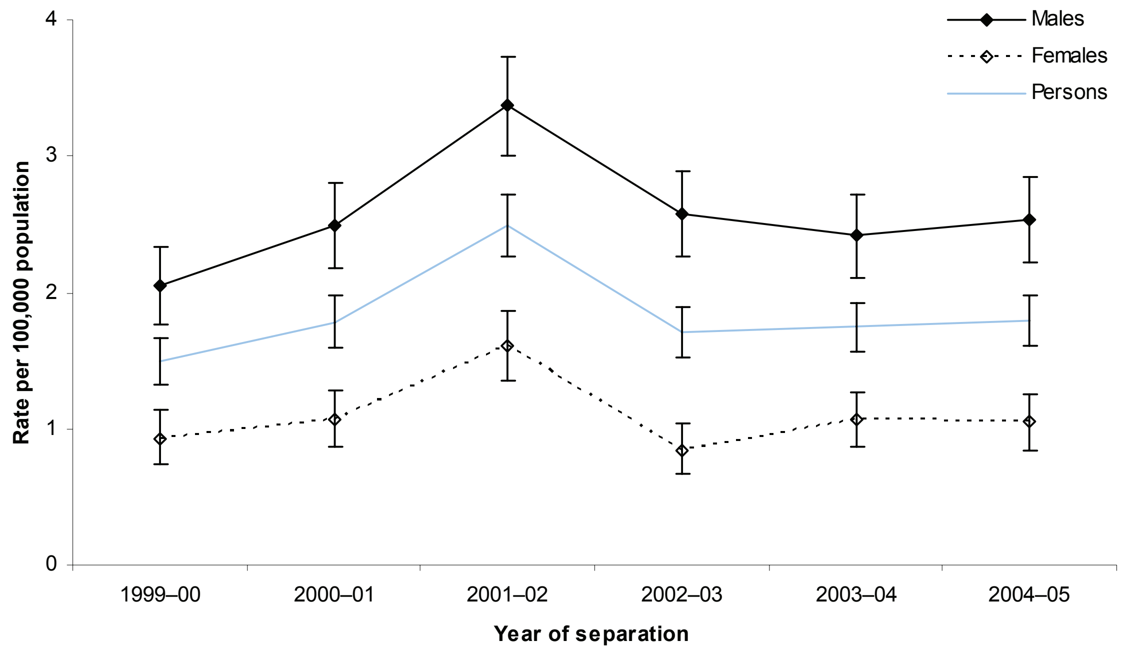


Figure 59: Age-standardised rates (± 95% CI) for hospitalised cases due to venomous marine animals and plants (X26) over time: males, females and persons, Australia 1999–05

While different types of marine bites and stings could not be identified in 2001–02 data, the high rate of hospitalised marine bites and stings observed in Figure 59 is thought to be due to an increase in box and Irukandji jellyfish sting cases. Jellyfish populations can be extremely variable from year to year and the 2001–02 stinger season was particularly severe; 90 days of continuous sampling for Irukandji jellyfish (*C. barnesi*) in far north Queensland caught 3 animals in 2000–01 while over 300 animals were caught in only 2 days in 2001–02 (CRC Reef 2002). Analysis of Irukandji jellyfish sting presentations to Cairns Base Hospital noted that the 2001–02 season produced the highest number of Irukandji syndromes on record, with 116 patients presenting to this single hospital in this year (CRC Reef 2002). The current analysis identifies 262 marine bite and sting cases hospitalised in outer regional Queensland in 2001–02 while in subsequent years (2002–05), the mean number of such presentations to hospitals in this region was 96.3. Conversely, elevated frequencies of marine bites and stings were not observed for other jurisdictions or for hospitals in the other remoteness regions of Queensland in this year. Like the Cairns Base study, we found that most of these 262 marine bite and sting cases hospitalised in outer regional Queensland in 2001–02 involved residents of Queensland (74.0%) or people thought to be visitors from overseas (no state of residence recorded, 16.0%).

It is noteworthy that the analysis of the Cairns Base cases reported that 76% of stings involved areas of the body that potentially could have been protected by stinger suits and that only 55% of patients had any effective first aid applied prior to arrival at the Emergency Department (CRC Reef 2002).

Age-standardised rates of hospitalised cases involving venomous marine animals and plants were low for residents of all Australian states and territories other than the Northern Territory (Figure 60 and Figure 61, presented on the same scale). The ACT is a land-locked territory and as such the very low incidence of marine bites and stings in the 1999–05 period among ACT residents was expected. Of the states and territories with a coast, the lowest rates of marine bite and sting cases were recorded for residents of Victoria, Tasmania and South Australia. As many venomous marine species are found throughout Australian waters (Williamson et al. 1996), this most likely reflects a low level of activity in the marine environment for residents of these colder southerly states. Relatively high rates of hospitalised marine bites and stings were observed for residents of Western Australia, Queensland and the Northern Territory. All three states contain large regions of warm, tropical waters, where both the density of venomous marine biota and the level of exposure to these creatures are high. Case numbers of marine bites and stings involving residents of the Northern Territory were small overall, which produced wide confidence intervals that overlapped with those for rates involving residents of Western Australia and Queensland. When rates of X26 cases were analysed for the entire six year study period, rates involving residents of the Northern Territory were found to be significantly higher than those of all other states and territories, including Western Australia and Queensland.

Rates of marine bite and sting cases remained relatively stable in most of the states and territories of Australia throughout the six-year study period. The two exceptions to this were rates for residents of the Northern Territory and residents of Queensland. As outlined above, case numbers in the Northern Territory were low, so the observed increase in marine bite and sting cases between 1st July 1999 and 30th June 2005 does not appear to be a significant trend. Conversely, a large proportion (29.4%, n=6,930) of marine bite and sting cases involved residents of Queensland and the resultant tighter confidence intervals suggest that the observed increase in rates in 2001–02 was significant. As explained above, the high rate of marine bites and stings observed in 2001–02 nationally was driven by particularly high frequencies of cases involving people hospitalised, and largely resident in, outer regional Queensland and this is demonstrated in Figure 60 (see also Figure 62).

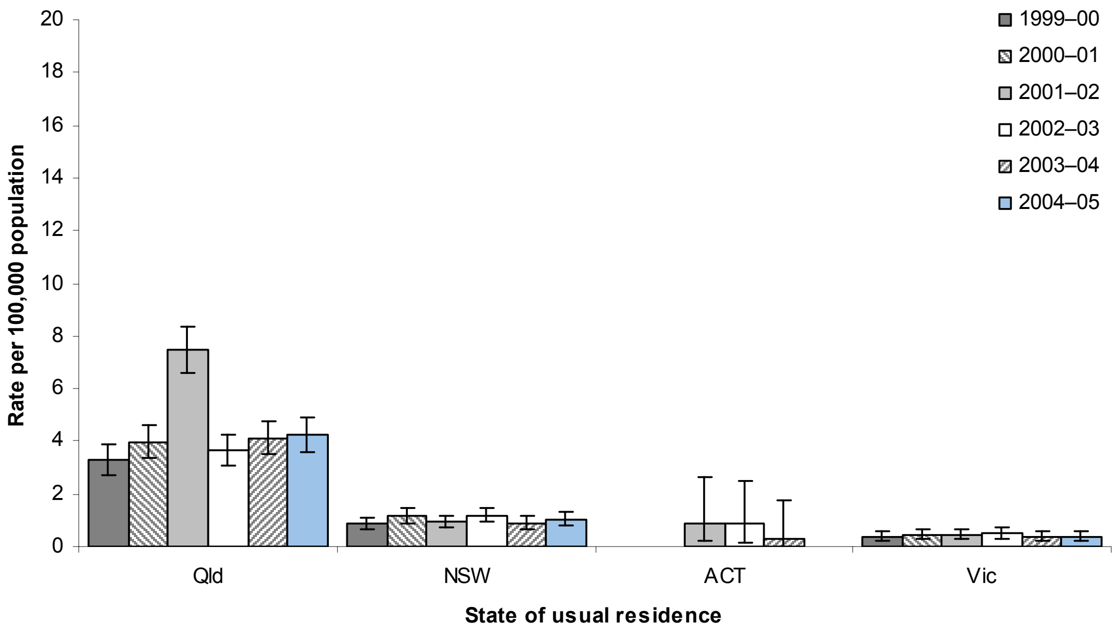


Figure 60: Age-standardised rates (± 95% CI) of X26 cases by state of usual residence, 1999–05: the Eastern states; Queensland, New South Wales, the ACT and Victoria

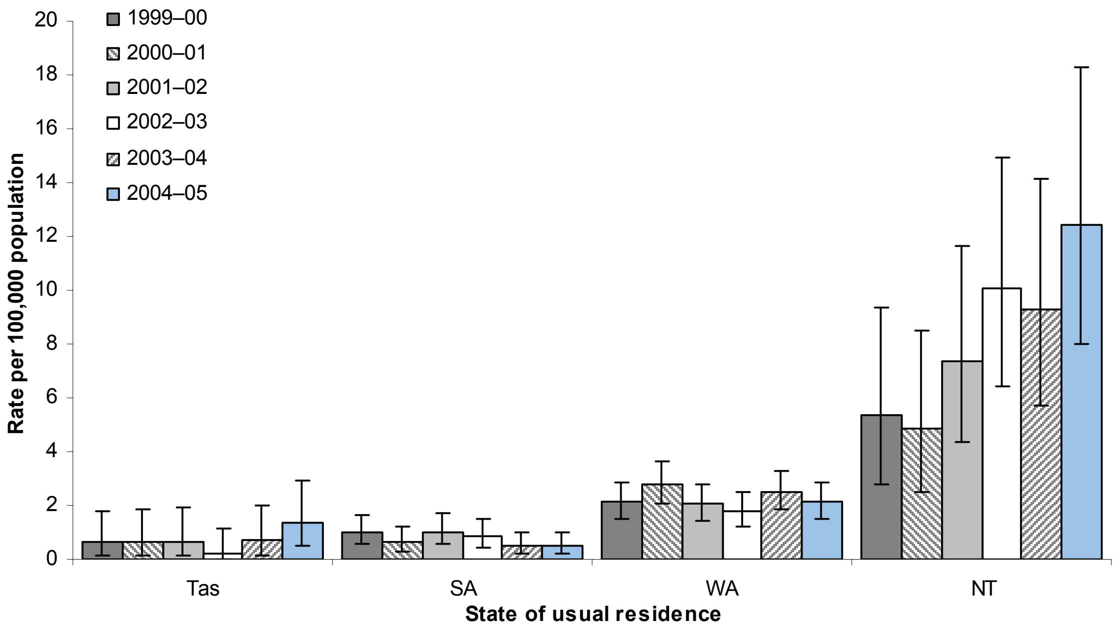


Figure 61: Age-standardised rates (± 95% CI) of X26 cases by state of usual residence, 1999–05: the other states of Australia; Tasmania, South Australia, Western Australia and the Northern Territory

Patterns of marine bite and sting cases according to the remoteness of the person's usual residence was similar to that seen for most other types of bites and stings. In all years, age-standardised rates were lowest for residents of Australia's major cities and highest for residents of Australia's most remote regions (Figure 62). Wide confidence intervals suggest that the rates of marine bite and sting cases did not significantly differ between residents of remote and very remote regions of Australia. Within each remoteness region, no consistent trend was observed for hospitalised marine bite and stings over the five year study period. However, as observed nationally and for residents of Queensland, particularly high rates of venomous marine bite and sting cases are reported for residents of Australia's outer regional areas in 2001–02. For residents of outer regional areas, a high rate of 9.5 marine bites and stings per 100,000 population was observed in 2001–02 and the number of cases (n=188), more than doubled those reported for both 2000–01 and 2002–03.

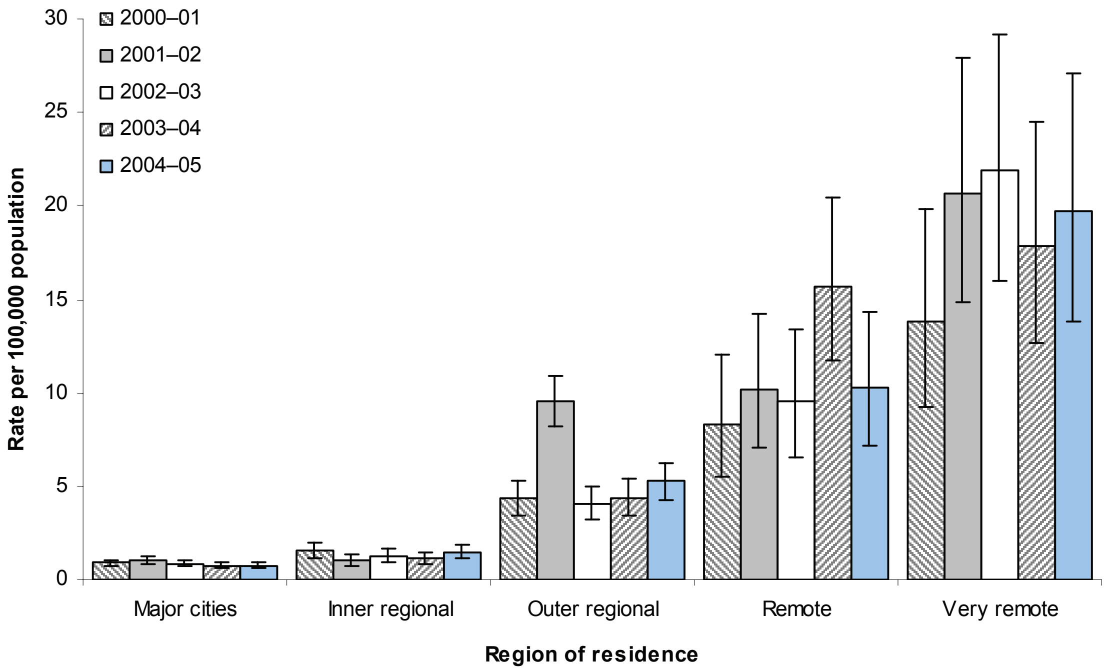


Figure 62: Age-standardised rates (± 95% CI) of X26 cases over time by region of usual residence, Australia 2000–05

7 Other venomous animals and plants (X22, X24, X27, X28 or X29)

7.1 Cases attributed to other venomous animals and plants, 2002–05

The remaining hospitalised cases due to venomous bites and stings during the 2002–05 study period were variously attributed to scorpions (X22), centipedes and venomous millipedes (X24), and other and unspecified venomous animals and plants (X27, X28 and X29, see Table 25).

A total of 239 incident separations with these principal external cause codes separated from hospital between 1st July 2002 and 30th June 2005, an average annual number of cases of 79.7 cases per year. Accordingly, the overall age-standardised rate of these venomous bites and stings (combined) was low: 0.4 per 100,000 population. The age-standardised rate of cases attributed to other venomous animals and plants (X22, X24, X27, X28 or X29) was similar for males and females (males: 0.5 per 100,000 population, females: 0.3 per 100,000), a M:F rate ratio of 1.5 to 1. Age-specific rates were relatively stable across the range (Figure 63). Higher proportions of cases attributed to scorpions and centipedes and venomous millipedes involved females. Males, on the other hand, were involved in higher proportions of cases attributed to 'other specified animals' and 'unspecified animals and plants' (Table 25).

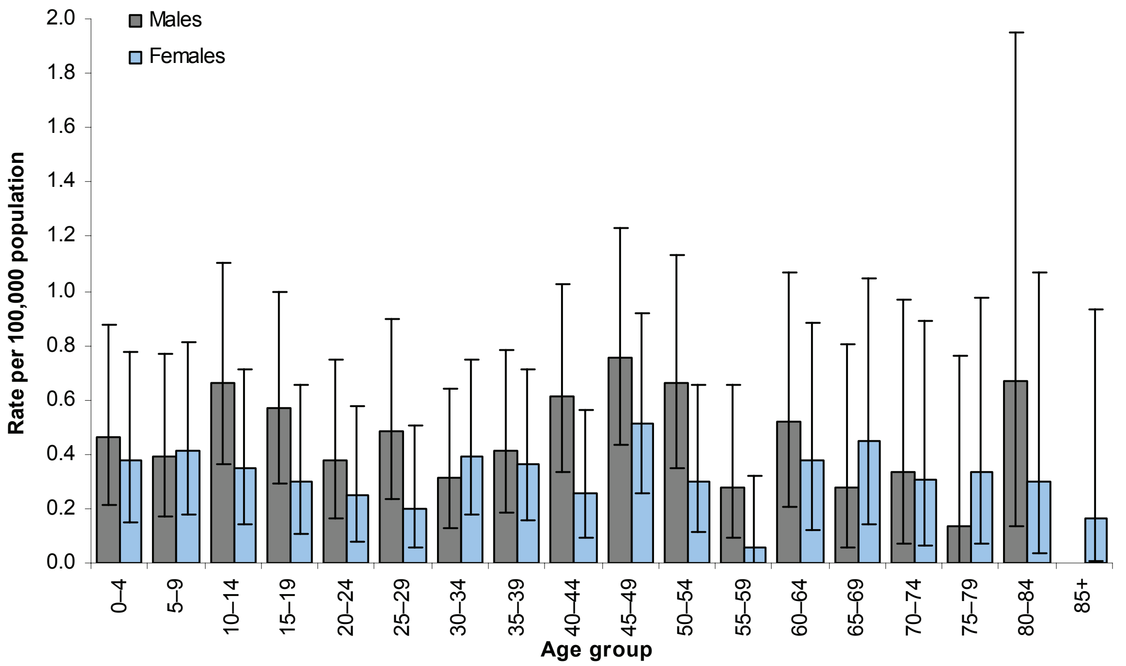


Figure 63: Age-specific rates (± 95% CI) for cases involving scorpions, centipedes and other venomous animals and plants (X22, X24, X27, X28 or X29): males and females, 2002–05

Table 25: Hospitalised cases attributed to scorpions, centipedes and other venomous animals and plants (X22, X24, X27, X28 or X29): males, females and persons, Australia 2002–05

External cause	Males	Females	Persons
Contact with scorpions (X22)	11 (7.7%)	13 (13.4%)	24 (10.0%)
Contact with centipedes and venomous millipedes (tropical) (X24)	15 (10.6%)	16 (16.5%)	31 (13.0%)
Contact with platypus (X27.0)	* (1.4%)	* (0.0%)	* (0.8%)
Contact with other and unspecified venomous animals (X27.8)	* (6.3%)	* (3.1%)	* (5.0%)
Other specified venomous plants (X28)	13 (9.2%)	10 (10.3%)	23 (9.6%)
Contact with unspecified venomous animal or plant (X29)	92 (64.8%)	55 (56.7%)	147 (61.5%)
Total	**142**	**97**	**239**

* Cells with small numbers (< 5) have been suppressed to prevent patient identification.

The principal diagnosis assigned to incident cases attributed to either X22, X24, X27, X28 or X29 external causes were understandably quite varied (Figure 64). Most scorpion stings received a T63.2 principal diagnosis (venom of scorpion) and similarly, most centipede and millipede stings were assigned the appropriate T63.4 diagnosis (venom of other arthropods). Both of the two cases involving a sting by a platypus received a principal diagnosis that described injuries to the wrist and hand. As expected, no cases coded to X28 (other specified venomous plants) had a principal diagnosis of T63 (toxic effect of contact with venomous *animals*). For these cases, injuries to the wrist and hand were relatively common, as were burns.

As seen previously for other types of bites and stings, reasonably large proportions of cases involving other venomous animals and plants (X22, X24, X27, X28 or X29) received a principal diagnosis from outside of the ICD-10-AM's injury and poisoning chapter. Like other types of venomous bites and stings, most of these (62.5%, n=35) described diseases of the skin and subcutaneous tissue.

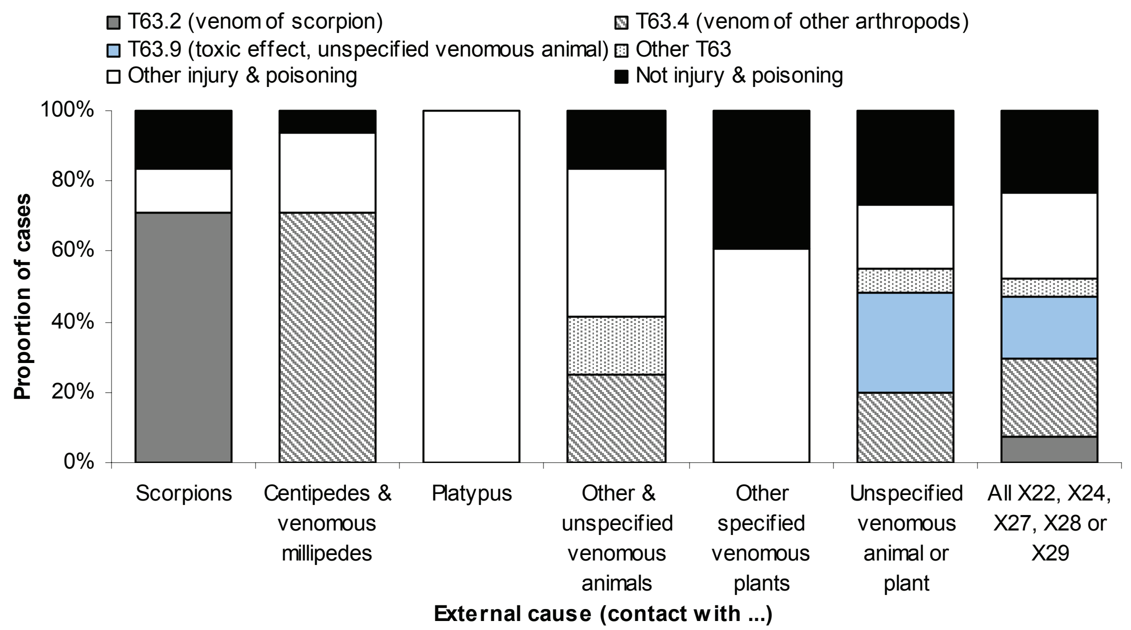


Figure 64: Principal diagnosis for hospitalised cases attributed to centipedes, scorpions or other venomous animals and plants (X22, X24, X27, X28 or X29), Australia, 2002–05

Like other types of venomous bites and stings, many cases coded as X22, X24, X27, X28 or X29 had an unspecified place of occurrence reported for the event (49.0%, n=117). Similarly, the home was the place of occurrence for a relatively large number of cases (24.3%, n=58). A further 14.6% (n=35) of cases coded to X22, X24, X27, X28 or X29 took place in other specified locations, such as beaches and forests.

Again, most of the cases involving scorpions, centipedes and other venomous animals and plants had an unspecified activity reported for the event (57.7%, n=138). This proportion was similar for each of the specific external cause codes in this group. A further 13.8% (n=330) cases recorded 'other specified activities', for which no further information was available. Approximately one in ten cases attributed to scorpions, centipedes and other venomous animals and plants (9.6%, n=23) were sustained while working for income and, again, many of these involved males working in the agriculture, forestry and fishing industries (39.1%, n=9).

The mean length of stay recorded for cases coded as contact with scorpions, centipedes and other venomous animals and plants varied according to the particular type of external cause for the case, but the standard error of these means suggest that this variation is not significant (Figure 65). Cases attributed to contact with scorpions (X22, n=24) had the longest mean length of stay for these cases; 3.6 days (± 6.8 SD). The two cases attributed to contact with a platypus had the shortest mean length of stay, with both cases only staying in hospital for one day each. Overall, the mean length of stay for all cases attributed to other venomous animals and plants was comparable to all other types of bites and stings; 1.9 days (± 3.0 SD).

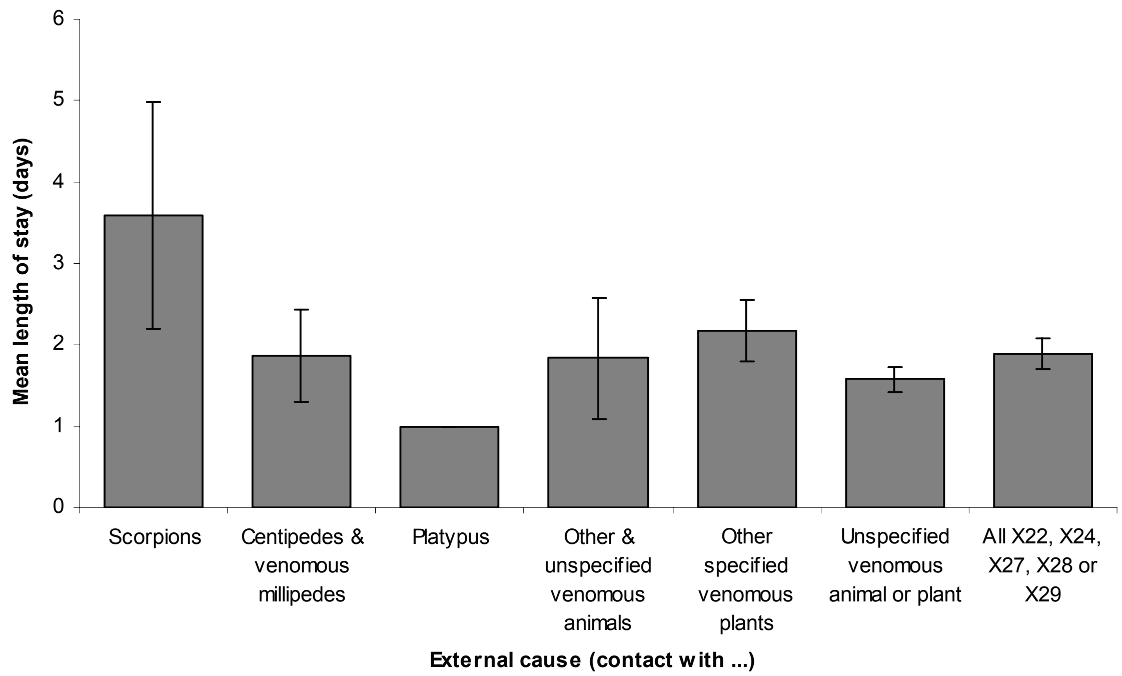


Figure 65: Mean length of stay (days ± SE) for cases attributed to scorpions, centipedes and other venomous animals and plants (X22, X24, X27, X28 or X29), Australia, 2002–05

7.2 Trends in rates of hospitalised cases attributed to other venomous animals and plants

All venomous bite and sting cases with a first external cause of X22, X24, X27, X28 or X29 were analysed for the period 1st July 1999 to 30th June 2005 (Figure 66). Age-standardised rates of hospitalised cases attributed to these codes, for both males and females, appeared to significantly decline throughout the study period.

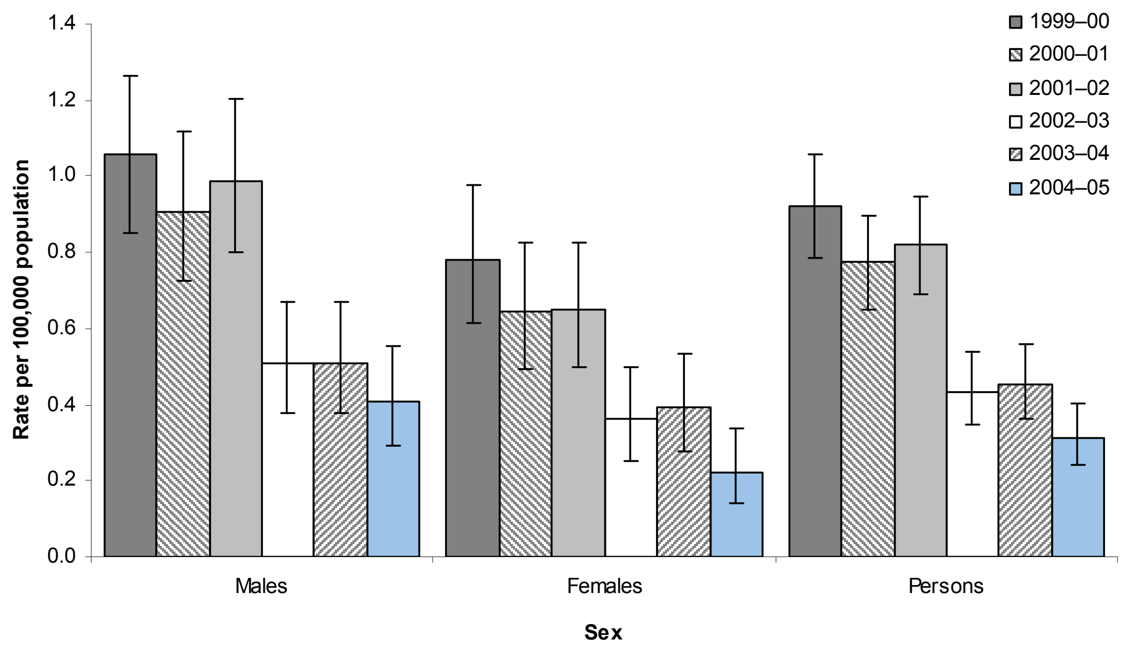


Figure 66: Age-standardised rates (± 95% CI) for all hospitalised cases with a first external cause of X22, X24, X27, X28 or X29: males, females and persons, Australia 1999–05

The marked drop in rates from 2002–03 coincides with the introduction of the third edition of the ICD-10-AM and its more detailed coding categories and explicit coding standards relevant to contact with venomous plants and animals. It is possible that these changes have helped coders to record case data more precisely, resulting in fewer cases being assigned 'other' and 'unspecified' external cause codes.

Evidence for this is the 51–57% decrease in the average number of cases coded as 'other venomous animals' (X27), 'other venomous plants' (X28) and 'unspecified venomous animals and plants' (X29) in the latter years of the study (third and fourth editions of the ICD-10-AM) compared to the average number of cases coded using earlier editions of the classification (Figure 67). In contrast, the number of cases attributed to contact with scorpions (X22) and venomous centipedes and millipedes (X24) did not show this marked decline.

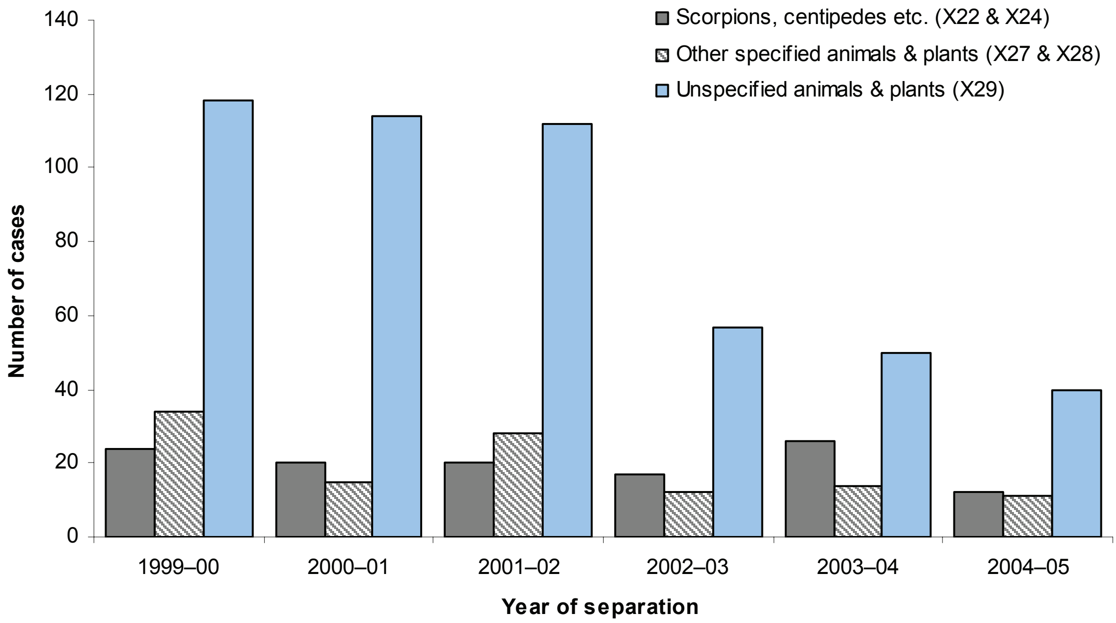


Figure 67: Numbers of cases attributed to contact with scorpions (X22), centipedes and venomous millipedes (X24), other specified venomous animals and plants (X27 and x28) and unspecified venomous animals and plants (X29): persons, Australia 1999–05

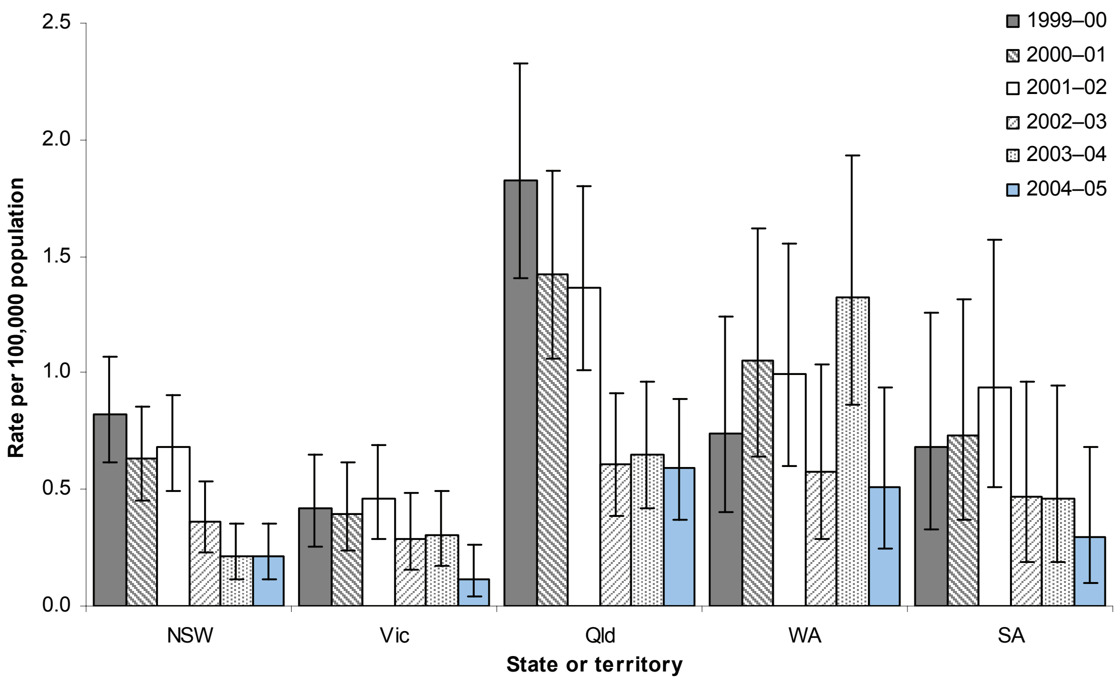


Figure 68: Age-standardised rates (± 95% CI) for cases with a first external cause of X22, X24, X27, X28 or X29: persons by state of usual residence (where total cases > 50), 1999–05

Age-standardised rates of hospitalised cases attributed to scorpions, centipedes and other venomous animals and plants varied according to the person's state of usual residence (Figure 68, restricted to states where 50 or more cases were identified in the 1999–05 period). As observed for many other types of venomous bites and stings, residents of Queensland generally had the highest rate of cases of these types, but wide confidence intervals suggest that these rates are not significantly higher than those for residents of many other states. Significant declines in the age-standardised rate are noted between 1999–00 and 2004–05 for residents of Queensland and residents of New South Wales. In both states a distinct drop in the rate of these hospitalisations occurred in 2002–03 and was maintained thereafter. A similar, but not significant, pattern was also observed for other venomous animals and plants cases involving residents of Victoria. As for the national data, rates for these types of venomous bites and stings for residents of these states declined in a step-wise fashion coinciding with the change to coding using the third edition of the ICD-10-AM.

As observed for most other types of venomous bites and stings, age-standardised rates of cases with a principal external cause of X22, X24, X27, X28 or X29 were lowest for residents of Australia's major cities and highest for residents of Australia's remote and very remote regions (Figure 69). The difference between rates in major cities compared to rates in outer regional, remote and very remote areas is significant. Annual rates of cases attributed to other venomous animals and plants varied slightly, with a general downward trend noted in each remoteness zone. Significant declines over the study periods were noted for residents of major cities and inner regional areas, matching the pattern of a decline in rates at the introduction of the third edition ICD-10-AM. In the other regions of Australia, these declines were not significant over the study period nor were rates consistently lower in each year.

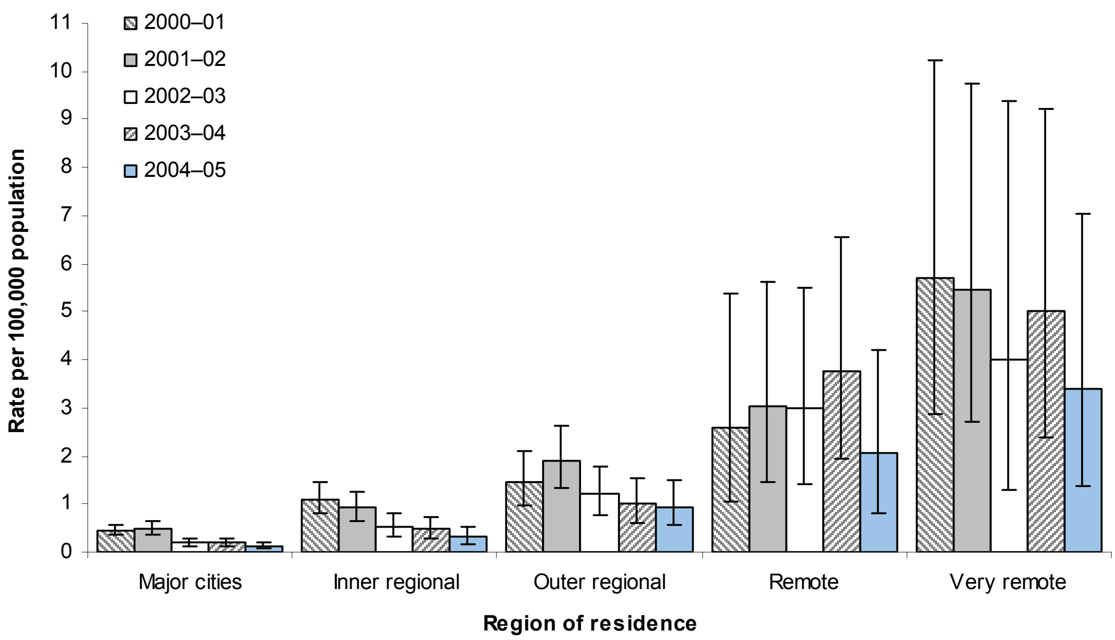


Figure 69: Age-standardised rates (± 95% CI) for cases with a first external cause of X22, X24, X27, X28 or X29: persons by remoteness of usual residence, Australia 2000–05

8 Discussion

A diverse range of dangerous species are present in the Australian flora and fauna (Sutherland 1983; Underhill 1995; Williamson et al. 1996) and recent estimates suggest that 227,300–345,400 people (1–1.8% of the population) had sustained a bite or sting injury in the four weeks prior to survey (ABS 2003; ABS 2006a). Nevertheless, these reported injuries include bites from non-venomous animals (e.g. dogs) and may not have required professional medical care of any kind (ABS 2003; ABS 2006b). This report confirms that contact with venomous plants and animals is a relatively infrequent cause of hospitalisation in Australia, with a little less than 4,000 cases per year separating from hospital in the 2002–05 study period. If the ratio of emergency department presentations:admissions due to bites and stings reported for Victorian hospitals (approximately 3:1, Winkel et al. 1998) can be extrapolated to national data, it is probable that about 12,000 emergency department presentations are made to Australian hospitals each year due to contact with venomous creatures. Fortunately, many hospitalised bites and stings require only a short stay in hospital and nearly all people are quickly discharged to their place of usual residence. Very few serious bites and stings in the present study resulted in death after admission to hospital.

The 2004–05 the National Health Survey (NHS) reported that females had a higher incidence of bites and stings than males (215,700 bites and stings in the four weeks prior to survey for females compared with 129,700 bites and stings for males ABS 2006a). However, this analysis found that males accounted for a far higher proportion of hospitalised venomous bite and sting cases than females. The observed gender differences may be related to levels of exposure, such as occupational and behavioural risk factors. Of the types of venomous creatures that would be commonly encountered around the home (e.g. spiders and venomous ants), the rates of hospitalised bites and stings for males and females are quite similar while for less common types of venomous creatures (e.g. snakes and venomous marine species), the rates of bites and stings involving males are much higher than those for females. The exception to this pattern is stings by wasps and bees. Barring apiarists (for whom numbers and gender break-downs are not currently available), it would be thought that males and females would have a similar level exposure to stings from wasps and bees. Nevertheless, and as has been found by others, our analysis suggests that males have a much higher rate of stings from wasps and bees than females; males, apparently, are more prone to being stung by wasps than females, even when engaged in the same activity (Notman & Beggs 1993). Research also suggests that males may experience a more severe reaction to bee stings than females (Roberts-Thomson et al. 1985), which may contribute to both the higher rate of admission to hospital and the disparity between the results presented here and the incidence of all bites and stings by gender reported by the 2004–05 NHS (ABS 2006a).

Rates of hospitalised bites and stings were generally higher for young people, with the mean age of a person admitted to hospital due to a bite or sting incident being 34.5 years (± 20.4 SD). This may be due to similar reasons to those outlined for the general preponderance of venomous bites and stings involving males; higher exposure levels in younger people. As for the observed sex differences in rates, age differences were less apparent for bites and stings by venomous creatures more typically encountered in and around the home (e.g. spiders and venomous ants) and more apparent for bites and stings that appeared to be more place- or activity-driven, such as venomous marine bites and stings. The prevalence of younger people amongst those admitted to hospital may also be influenced by admission practices however. While research demonstrates that children often have a more severe reaction to bites and stings from venomous creatures (Trethewy et al. 2003; Isbister 2004b), justifiable parental concern may see a larger proportion of cases involving younger children admitted to hospital for observation in cases where envenomation is not confirmed (e.g. Mead & Jelinek 1993; Mead & Jelinek 1996). Regrettably, current diagnosis and health intervention coding practices do not facilitate the determination of cases that actually involve toxic effects and/or the administration of anti-venoms or similar over cases that require only monitoring following contact with venomous animals and plants; most cases are assigned a T63 principal diagnosis and most cases are not assigned health intervention codes. While the Australian Coding Standards are quite clear on this matter, it is apparent that the coding of many hospital separations due to venomous bites and stings is currently insufficient to meet the needs of injury prevention researchers. Unfortunately, the best measure of envenomation, Venom Detection Kit (VDK) and anti-venom usage remains the voluntary system of reports and questionnaires returned to the Commonwealth Serum Laboratories (see Sutherland 1992b).

8.1 Types of hospitalised bites and stings

The most common causes of hospitalisation due to contact with venomous animals and plants were spider bites and stings by wasps and bees. These types of venomous bites and stings accounted for nearly two-thirds of all such cases in each of the three study years. The expanded codes regarding the types of organisms attributed to bite and sting cases included in recent editions of the ICD-10-AM revealed that most serious spider bite cases are due to contact with redback spiders. Bites by the highly venomous funnel-web spiders and the white-tailed spiders previously thought to provoke necrotising arachnidism accounted for relatively few cases. For a large proportion of cases, the type of spider involved was unspecified, which is understandable given the rather cryptic nature of most common species and the difficulty of identifying the culprit without specialist knowledge (formal identification of spiders captured at the time of the bite is recommended for valid attribution, see Isbister 2002; Isbister 2004b).

Specific coding separating hornet, wasp and bee stings was introduced in the second edition of the ICD-10-AM (NCCH 2000). These categories were further expanded to describe particular types of wasps and bees in the fourth edition of the ICD-10-AM (NCCH 2004). Three-quarters of the cases coded as stings by wasps and bees for the period 2002–05 were attributed to bees and 22.3% of cases were attributed to wasps. When the single year coded to the fourth edition ICD-10-AM (2004–05) was analysed, a surprising number of wasp and bee stings were not attributed to any specific type of wasp or bee (>80%). The most aggressive wasp and bee species that occur in Australia are the introduced European and English wasps (*Vespula germanica* and *V. vulgaris*) and the introduced honey bee (*Apis mellifera*). Nevertheless, few records explicitly attributed the sting incident to these species. Given the large proportion of unspecified stings, it may be that many assume that these are the only hymenoptera species that are capable of serious stings and so do not name the culprit. Native wasps and bees, and the introduced bumblebee, may be more distinct or unusual stinging creatures and as such may get specifically attributed in records in greater proportion to their actual incidence.

Hospitalisations due to contact with snakes occur at a much lower frequency than would be expected given the notoriety of Australia's venomous reptile fauna. An average of 583.3 cases of snakebite (only one venomous lizard bite was recorded in the period) separated from hospital in each of the three study years. Identification of the type of snake involved in a bite incident is aided by the use of Venom Detection Kits (VDKs, Sutherland 1992b; White 1998; White 2001). Snakes of the brown snake immunotype were the most common type involved in hospitalised cases, followed by black snake immuntypes and tiger snake immunotypes. The incidence of tiger snake bites appears to be lower than previously thought on the basis of fatalities (e.g. Sutherland 1983). This may represent changes in the species' distributions whereby populations of these types of snakes may be reduced and, potentially, this niche filled by the more cosmopolitan brown snakes (e.g. White 2000; Currie 2006). Alternatively, the use of VDKs may be improving species identification. The less common, though highly venomous, taipans, death adders and sea-snakes accounted for very few bite cases in the study period. Between 15–54% of cases, depending on the type of snake involved, did not have a principal diagnosis of 'toxic effects of contact with venomous animals' (T63), suggesting that envenomation did not take place.

Bites and stings attributed to venomous arthropods (X25) accounted for 9.7% of the cases in the 2002–05 study period. These cases were commonly attributed to bites by venomous ticks and stings from venomous ants. Most ant stings were due to contact with jumper and bull ants (*Myrmecia* spp.), accounting for 60.8% of the cases. Stings by the red imported fire ant (*Solenopsis invicta*), which has infested areas around Brisbane and forms super-colonies which are aggressively defended (see Solley et al. 2002), were not observed to result in any hospitalisations in the three-year study period. Rates of ant stings were highest for young males and older females, and a large proportion of cases occurred in and around the home. The ICD-10-AM third and fourth editions do not dissociate tick bites by type but it is likely that the two species most frequently involved in hospitalisations are the Australian paralysis tick (*Ixodes holocyus*) and the Tasmanian paralysis tick (*Ixodes cornuatus*). Ticks were responsible for nearly half of the cases coded with a leftmost external cause of X25 in the period 2002–05. Like ant stings, rates of serious tick bites were highest for younger children but unlike ant stings, high rates of tick bites were not observed for older adults. Compared to ant stings, a lower proportion of tick bites occurred in the home.

Approximately one in ten hospitalised bite and sting incidents in the period 1st July 2002 to 30th June 2005 was due to contact with venomous marine animals and plants. Jellyfish were the most common type of venomous marine creature attributed to an incident, accounting for just over a third of cases (36.0%). Irukandji jellyfish (e.g. *Carukia barnesi*) were responsible for the majority of cases (64.0% of jellyfish stings), while the notorious box jellyfish (*Chironex fleckeri*) accounted for fewer cases than expected (7.7%). Relatively high numbers of separation records for cases involving venomous marine creatures did not have a state of usual residence recorded, suggesting the person was an international visitor. Assessment of the person's country of birth for these cases suggests that most, if not all, were born overseas. Nearly one in five stings by Irukandji jellyfish in 2002–05 (17.9%, n=43) involved an international visitor by these measures. This finding supports calls for increased prevention efforts targeted to international visitors regarding the potentially fatal jellyfish species common in Australian waters (e.g. Harrison et al. 2004; Leggat et al. 2005).

Stonefish and other stinging fish were also frequent causes of marine-related bite and sting hospitalisations, together accounting for 18.3% of cases. Stingrays were another common cause of hospitalisation (16.5% of cases). Other specified creatures, including cone shells, stinging corals and sea urchins, accounted for a further 18.2% of marine-related cases. While the venoms of these organisms can be highly toxic, the relatively large proportions of cases that had principal diagnosis codes signifying physical injury, rather than toxic effects, is indicative of the level of physical damage that can be inflicted by these creatures via spines, barbs, darts and other irritants.

Less than one percent of venomous cases were attributed to bites and stings due to contact with scorpions (X22), centipedes and venomous millipedes (X24), other specified venomous animals (including the platypus, X27) and other specified venomous plants (X28). A further 1.3% of cases were attributed to unspecified venomous animals and plants (X29). While the rates of these types of bites and stings were low, as for most other types of bites and stings males had higher rates than females. Unlike most other types of bites and stings, however, there was no distinct age-related pattern to these cases.

8.2 The circumstances of venomous bites and stings

As mentioned previously, about a third of venomous bite and sting cases occurred in the home; both for cases generally and for most of the specific types of bites and stings. Currently, the ICD-10-AM place of occurrence codes describes two subcategories for the home; the driveway and the home itself. As such, this contributes little to the development of prevention initiatives. This observation supports further revision of place of occurrence coding's 'home' category. As outlined by Henley and Harrison (2006), one suggested change to the 'home' place of occurrence coding is to include subdivisions in the category which describe which room of the home the injury was sustained. That this type of revision would be effective for many bite and sting hospitalisations is demonstrated by the observation that bites by particular spiders are more common inside homes, predominantly bathrooms, while bites by other types of spiders are more common in the garden of the home (Isbister 2002). This information could be valuable for public awareness and injury prevention initiatives.

Intuitively, many bite and sting cases that do not occur in the home would occur in areas of forest or bushland, oceans, streams and beaches, farms, sporting grounds and schools. Current ICD-10-AM coding covers all of these areas and more (see NCCH 2004). Nevertheless, for every type of bite and sting except for contact with venomous marine animals and plants, the most frequent place of occurrence code assigned to cases was 'unspecified'. This suggests that more detail regarding the incident needs to be included in the hospital record in order for the circumstances of these events to be understood, allowing prevention programs to be more appropriately targeted.

Similarly large proportions of bite and sting cases recorded an 'unspecified' activity code, frequently in excess of 60% of cases for particular types of bites and stings. Currently, ICD-10-AM activity coding is extremely detailed for sport and leisure activities but somewhat limited for other types of activities. For example, the activity 'while engaged in other types of work' is strongly associated with bites and stings than occur in the home. Analogous to the expansions recommended for this place of occurrence, the 'while engaged in other types of work' could be usefully subcategorised to explicitly describe housework, gardening, home maintenance, studying or any of the other types of activities which currently fall in this wide category. Good use of the expanded sports coding is demonstrated for bites and stings involving venomous marine organisms but even so, more than a third of these cases reported an unspecified code. This observation suggests that the frequency of use of the 'unspecified' code may not solely be due to a lack of appropriate activity categories but may also be due to a lack of information contained within the hospital record. As for place of occurrence information, it is suggested that clinicians include more detail regarding the incident in the hospital record so that the circumstances of these events to be understood, contributing to prevention initiatives.

8.3 Trends in bites and stings over time

This report also analysed the rates of bite and sting cases over time, for the years in which hospital records were coded to the ICD-10-AM nationally (1st July 1999 to 30th June 2005). A distinct step-wise drop in rates for venomous bite and sting cases (X20–X29) was observed from 2002–03. It appears that this is a result of the coding changes made from the third edition of the ICD-10-AM that provided an unambiguous category for coding bites from snakes of unknown toxicity. Coding standards for separations related to snakebites (both venomous and non-venomous species) were also included from the third edition of the ICD-10-AM, which may have clarified issues for hospital coding staff. Revised analyses of rates over time for both X20–X29 cases *and* cases coded to W95.1 (snake of unknown toxicity) suggested that rates of (potentially) venomous bites and stings were stable throughout the 1999–05 period.

Similarly, age-standardised rates over time for particular types of venomous bites and stings (e.g. X21, spiders; X23, hornets, wasps and bees) generally remained stable. Initial analyses of hospitalised snakebite cases presented the same step wise decline from 2002-03 as observed for national data, and it was this specificity that alerted us to the effect of changes to codes outside of the X20-X29 ‘venomous’ range. With W59.1 cases included, rates of snakebite were relatively stable over time. One further observation of declines in rates coincident with the introduction of the third edition codes involved the small numbers of cases coded to X22, X24, X27, X28 or X29. While these cases were analysed as a group, it appears that strong declines in the number of cases coded to ‘other’ or ‘unspecified’ venomous animals and plants coincide with the introduction of more specific subcategories for particular species or groups of venomous creatures. While this complicates assessment of trends, it should be regarded as evidence of the improved capability of the ICD-10-AM to describe these types of cases.

The rates of bite and sting cases over time were also analysed according to the person’s state of usual residence. The results of these analyses were largely as expected, generally reflecting the known distributions of the venomous species in question and/or the expected level of exposure to these creatures. For example; while venomous marine animals are relatively common in all Australian waters (Underhill 1995; Williamson et al. 1996), rates of marine-related bites and stings were highest in the Northern Territory, Queensland and Western Australia, where the warm, tropical climate encourages water-based activities. Similarly, high rates of wasp stings for residents of Queensland reflected known sensitivities to *Polistes* spp. and *Ropalidia* spp. venoms in this population (Solley 1990; McGain et al. 2000) while high rates of ant and other venomous arthropod bites and stings (X25) for residents of Tasmania reflect the high level of sensitivity to *Myrmecia pilosula* (jack-jumper ant) venom in this population (McGain & Winkel 2002; Brown et al. 2003). That the 2001–02 marine stinger (jellyfish) season was particularly severe (see CRC Reef 2002) was substantiated by this report, with high rates of cases coded to X26 observed to involve residents of Queensland and residents of outer regional zones. Further investigation confirmed that this atypical frequency of marine bites and stings was restricted to cases *admitted* to hospitals in outer regional Queensland.

The only surprising result from the state-based analyses was the very high rate of bee sting cases involving residents of South Australia. Current statistics regarding the numbers of apiarists active in each state or territory are not available, but we found no evidence that South Australians are particularly enthusiastic bee-keepers (see Paton 1996). Similarly, there does not seem to be much ecological evidence to suggest that South Australia is a hotspot for feral (unmanaged) bee populations, although feral colonies are known to exist on Kangaroo Island, the Yorke Peninsula and in the south-east of South Australia (Paton 1996). That residents of Western Australia have the second highest rates of hospitalised bee sting cases suggests that there may be a climatic component underpinning these findings. Research also suggests that South Australia has had a particularly high rate of bee sting fatalities historically (Harvey et al. 1984; Underhill 1995). Perhaps a particular sensitivity to bee stings is present in the South Australian population like that observed for Queenslanders and Tasmanians (e.g. Underhill 1995; see also Brown et al. 2003).

Few significant trends were observed for the rates of bite and sting cases according to the person's state of usual residence. That is, rates for all bites and stings and for the different types of bites and stings either remained steady throughout the six year study period or fluctuated considerably so that no consistent pattern was evident. The main exception to this was the rate of snake bites involving residents of the Northern Territory when W59.1 cases (snake of unknown toxicity) were considered. Contrary to the rates observed for residents of the other states and territories of Australia, rates of venomous snakebites (X20) were stable over time for residents of the Northern Territory. Including W59.1 cases drove rates of snakebites involving residents of the Northern Territory up considerably from 2002–03. It appears, then, that changes made to these codes and/or the coding instructions detailed from the third edition of the ICD-10-AM onwards have not been adopted in the Territory. Accordingly, when adjustments were made to account for these changes, cases hospitalised in the Northern Territory with a W59.1 external cause were not included in the analyses.

Results of analyses of rates of bites and stings according to the remoteness of the person's usual residence were also largely unsurprising. The distributions of many venomous species are centred in remote and very remote regions and in more urban areas habitat disturbance has most likely reduced the numbers of venomous creatures. As such it was not unexpected to observe that for many types of bites and stings, residents of major cities had the lowest rates of incidence while residents of remote and very remote regions had the highest rates of incidence. The exceptions to this generality were cases involving wasps and bees and ants and ticks; all very small creatures that may cope well with a degree of habitat disturbance and/or accommodate, and even benefit from, the presence of humans and their built structures (e.g. spiders, managed bees). Interestingly, the rates of bee stings are highest for residents of outer regional and remote areas and quite low for residents of very remote regions. This may describe some sort of climatic barrier against the establishment of feral bee populations, with either very hot and dry (desert regions) or very hot and very wet (the northern tropics) preventing colonisation.

The pattern of rates over time according to the state or region of a person's usual residence varied widely. Frequently, rates of venomous bites and stings remained statistically stable over time in most regions of Australia. A notable change in the rate in only one region of the country for particular bite or sting types were also common observations. In such cases, population change and development, or the actual classification of the regions, may have provoked these trends.

Contact with venomous animals and plants represented a very small proportion of the number of hospitalisations due to external causes separating from Australian hospitals in the period 1st July 2002 and 30th June 2005. Most bite and sting cases were due to contact with spiders and wasps and bees. The rates of these types of cases have not significantly changed for the six year period for which hospital separations have been coded to the ICD-10-AM nationally. Rates of snakebites however, appear to have significantly declined over the period if revisions of the ICD-10-AM addressing bites by snakes of unknown toxicity are not taken into account. Presumably assisted by Venom Detection Kits, bites attributed to venomous snakes had a low proportion of cases described as bites from unspecified snakes. For other types of venomous bites and stings, particularly wasp and bee stings, far larger proportions of cases were described as due to unspecified organisms. Capturing greater detail of the specific type of creature involved in the incident may inform both clinicians and injury prevention professionals. It is possible that the first step required for prevention initiatives is greater education regarding identifying potentially venomous species. Similarly, improved reporting of the place of occurrence and the activity being undertaken at the time of the hospitalised bite or sting would greatly contribute to efforts to prevent these cases.

9 Data issues

Data sources

Hospital separations data were provided by the Australian Institute of Health and Welfare (AIHW), from the National Hospital Morbidity Database (NHMD).

Estimated resident population (ERP) data by age, sex and place of usual residence was also obtained from the AIHW. As hospital data was analysed in financial year blocks, ERPs were for 31st December of each relevant year. ERPs according to the person's remoteness of usual residence are only available for 30th June dates. As such, the ERPs for the two years spanning the financial year of interest were averaged to give the denominator for rate calculation.

Selection criteria

All hospital records with a leftmost external cause in the range X20–X29 were extracted from the NHMD data. NHMD records are de-identified and do not contain a flag indicating that the separation is the first in a sequence and/or the separation is the second or subsequent record in a sequence (that is, readmissions for the same incident cannot be identified). As such, through inter-hospital transfers and readmissions, the number of separations in the dataset is greater than the number of cases that provoked these episodes of care. In order to estimate the number of bite and sting cases that led to hospitalisations in the study period, separations that had a mode of admission indicating the person had been transferred from another acute hospital were omitted from the main analyses.

During the analyses it became apparent that changes to the third edition ICD-10-AM had influenced the rates of cases attributed to X20–X29 external cause codes. Particularly apparent for rates of bites from venomous snakes (and lizards, X20), it was suspected that many cases previously coded to X20 were now being coded as W59.1, bites by snakes of unknown toxicity. It was also apparent that hospitalisations involving venomous snakes in the Northern Territory were not effected, suggesting that the coding changes from 2002–03 had not been applied in this jurisdiction. As such, hospitalised cases (i.e. not inward transfers) of W59.1 from jurisdictions other than the Northern Territory were included in both analyses over time for all venomous bites and stings and for snakebites in particular.

Rate calculation

Rates of hospitalised bites and stings were calculated per 100,000 population and standardised to the Australian population as at 30th June 2001 using the direct method. Age-specific rates were calculated in 5-year age groups to 85 years and older.

Rates presented according to the person's state of usual residence of remoteness classification of usual residence may slightly misrepresent the geographic distribution of bite and sting events; an Australian resident may have sustained their serious bite or sting while on holiday in a different region or the person bitten or stung may have been an international visitor and as such place of usual residence data was not reported in the separation record.

Confidence intervals

Confidence interval calculations were based on the methods described in Berry and Harrison (2006). Where case counts were greater or equal to 100, symmetrical 95% confidence intervals were calculated using the formula:

1.96 x age-standardised rate / square root (N)

Where case counts were less than 100, asymmetrical 95% confidence intervals were calculated using the formula:

Upper CI: Rate * upper confidence factor

Lower CI: Rate * lower confidence factor

The confidence factors were taken from page 107 of Berry and Harrison (2006).

Small case count issues

Table cells that contain less than five cases suppressed to protect patient confidentiality. In the instances where only one cell in a row or column has a count of 5 or less, some other cells in the same row or column have also been suppressed.

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This report describes the bites and stings due to contact with venomous animals and plants that resulted in a separation from an Australian hospital in the period 1 July 2002 to 30 June 2005. Analyses of bite and sting cases over time (1999–2005) are also presented.

Hospitalised bites and stings were most frequently attributed to spiders, bees and wasps while snakebites were a less frequent cause of hospitalisation. Higher rates of serious bites and stings were generally observed for males and for younger people. Little change in the rate of hospitalised bites and stings was noted over time.

This report demonstrates that changes made to the ICD-10-AM classification system from 1 July 2002 have greatly improved the specificity and utility of hospitalised bite and sting data.