Australian Government
Australian Institute of Health and Welfare

Flinders University

Pedal cyclist deaths and hospitalisations

1999–00 to 2015–16

AIHW

Australian Government
Australian Institute of
Health and Welfare

Injury Research and Statistics Series

Number 123

Pedal cyclist deaths and hospitalisations

1999–00 to 2015–16

Australian Institute of Health and Welfare
Canberra
Cat. no. INJCAT 203

The Australian Institute of Health and Welfare is a major national agency whose purpose is to create authoritative and accessible information and statistics that inform decisions and improve the health and welfare of all Australians.

This publication is part of the Australian Institute of Health and Welfare's Injury research and statistics series. A complete list of the Institute's publications is available from the Institute's website www.aihw.gov.au.

ISSN 2205-510X (PDF)
ISBN 978-1-76054-524-6 (PDF)

Suggested citation

AIHW: R Kreisfeld & JE Harrison 2019. Pedal cyclist deaths and hospitalisations, 1999–00 to 2015–16. Injury research and statistics series no. 123. Cat. no. INJCAT 203. Canberra: AIHW.

Any enquiries relating to copyright or comments on this publication should be directed to:
Australian Institute of Health and Welfare
GPO Box 570
Canberra ACT 2601
Tel: (02) 6244 1000
Email: info@aihw.gov.au

Published by the Australian Institute of Health and Welfare

This publication is printed in accordance with ISO 14001 (Environmental Management Systems) and ISO 9001 (Quality Management Systems). The paper is sourced from sustainably managed certified forests.

MIX
From responsible sources
FSC® C017269

Please note that there is the potential for minor revisions of data in this report.
Please check the online version at www.aihw.gov.au for any amendments.

Contents

Summary

This report looks at injury hospitalisations for pedal cyclists in 2015–16, as well as trend information for deaths and hospitalisations from 1999–00 to 2015–16.

In 2015–16:

- about 12,000 cyclists were hospitalised due to injuries sustained in a crash—this was 1 in 5 of the 60,000 people hospitalised due to injury in a land transport crash
- nearly 6 in 10 of hospitalised cyclists were injured in an on-road crash (6,900 or 58%), and the rest were injured off-road
- nearly 6 in 10 hospitalised cyclists had sustained a fracture, with the most common injury being a fractured upper limb.

Between 1999–00 and 2015–16:

- 651 cyclists died, an average of 38 deaths a year
- of cyclists who died, nearly 8 in 10 were aged 25 and over, and 9 in 10 were male
- nearly 160,000 cyclists were hospitalised, an average of more than 9,000 each year
- across all ages, the rate of hospitalisation rose by an average of 1.5% each year
- the proportion aged 25 and over rose, while the proportion aged under 25 fell
- modelling showed a non-statistically-significant decline in cyclist deaths of 1% per year.

Hospitalisation rates rose for cyclists, but fell for other road users

The overall rate of hospitalisation due to pedal cyclist injury rose between 1999–00 and 2015–16, though year-to-year fluctuations varied. The modelled trend for the whole period shows an average rate rise of 1.5% per year, though this rise was faster over the more recent 6-year period (an average increase of 4.4% per year).

This pattern differs from that for motor vehicle occupants, which fell by 1.3% per year, and for pedestrians, which fell by 2.2% per year.

While the hospitalisation rates of pedal cyclists for on-road and off-road crashes fluctuated over the 17 years, both rates recorded similar increases since 2010–11, of 4.7% per year for on-road and 4.3% for off-road.

Nearly 6 in 10 hospitalised cyclists sustained a fracture

Fractures were the most common type of injury (55%) sustained by cyclists of all ages, and were most likely to occur among hospitalised cyclists aged 45–64 (61%).

Of all cyclists who sustained a fracture, 6 in 10 fractured an upper limb. The highest proportion of upper limb fractures was among those aged 5–14 (78%), and the highest proportion of head and neck fractures was among those aged 0–4 (21%).

More older cyclists were hospitalised

Two participation surveys of people aged 15 and over found a large increase in cycling among older adults since 2001, while participation fell or rose only slightly in younger age groups.

Consistent with these findings, the age profile of cyclists who were hospitalised after a crash has changed since 1999–00—in more recent years, more were aged 25 and over, and fewer were aged under 25.

Older cyclists had more severe injuries

The severity of injuries sustained by cyclists generally increased with age. Compared with cyclists aged under 45, those aged 45 and over:

- were more likely to have life-threatening injuries
- stayed longer in hospital
- were more likely to be transferred to another hospital.

In severe cases, injured cyclists might need to be put on a ventilator to help them breathe. In 2015–16, cyclists required about 15,000 hours of continuous ventilatory support. Cyclists aged 45 or older consumed 90% of the total hours of ventilatory support, with more than half provided to those aged 45–64.

1 Introduction

Data on the number of pedal cyclists killed in on-road or off-road crashes, or hospitalised after cycling crashes, are important sources of information about the extent of serious cyclist injury.

Hospital data are a much more complete source of information on serious non-fatal pedal cyclist injuries than crash data, the main other source (Austroads Ltd 2019). State and territory agencies use data on fatal and non-fatal crashes to inform policy and plans to improve road safety.

This report looks at pedal cycle injury hospitalisations in Australia in 2015–16, as well as trends for deaths and hospitalisations over the 17 years from 1999–00 to 2015–16. Deaths are comparatively uncommon, and their numbers vary considerably between years, so it is preferable to rely on averages derived from cases that occurred over a longer period.

The report looks at and compares injuries that occurred on-road and off-road. It also analyses cyclist injuries by age and sex, in light of a previous report that showed strong rises in hospitalised injury of pedal cyclists, particularly for middle-aged males (AIHW: Henley & Harrison et al. 2015).

Cyclists in Australia

Data on how many Australians participate in cycling is limited and inconsistent. This report includes information from 3 population surveys to provide context for the numbers and rates of cyclists admitted to hospital with injuries. For more information about the surveys, see Appendix B.

Adults

According to the Participation in Sport and Physical Recreation Survey (PSPRA), done by the Australian Bureau of Statistics (ABS), the estimated number of cyclists aged 15 and over rose from about 1 million in 2005–06 to 1.25 million in 2013–14 (24%). The number of cyclists fell slightly between 2011–12 and 2013–14 (see Figure B1.1 in Appendix B).

But according to the Participation in Exercise, Recreation and Sport Survey (ERASS), done by the Australian Sports Commission in conjunction with state and territory governments, the number of cyclists aged 15 and over rose by 45% between 2001 and 2010—from 1.44 million to 2.08 million.

Looking at the data from the PSPRA and ERASS surveys by age group, it seems that participation rose greatly among older adults, and fell or rose only slightly in the younger age groups (see Appendix B).

Children

According to the ABS Survey of Children’s Participation in Cultural and Leisure Activities, in 2012, an estimated 1 million boys and 770,000 girls aged 5–14 had cycled in the 2 weeks before the survey (ABS 2012a). Participation in cycling had remained fairly stable since 2000 (see Figure B1.3 in Appendix B).

Other survey data

The National Cycling Participation Survey (Austroads Ltd 2017) reported that male cycling participation fell from 47% in 2011 to 40% in 2017, and female cycling from 45% to 29%.

The survey data suggest a modest decline in rates for children under 10, and found declining rates in those aged 30–49 and 50 and over, which is at odds with data from the PSPRA and ERASS surveys.

Data used in this report

Data on injury hospitalisations and trends are from the National Hospital Morbidity Database (NHMD) for 1 July 1999 to 30 June 2016.

Injury deaths data are from the ABS cause of death unit record files (CODURF) for 1999 to 2016. CODURF data are provided to the AIHW by the Registries of Births, Deaths and Marriages and the National Coronial Information System (NCIS), and are coded by the ABS. The data are maintained by the AIHW in the National Mortality Database. NCIS cases were also looked at to obtain contextual information.

Ideally, information would also have been included on emergency department presentations. But it is not possible to identify cases of cyclist injury in the emergency department data source, the National Non-admitted Patient Emergency Department Care Database, as it does not include external cause codes.

For more information about the data sources and data issues, see Appendix A.

Structure of this report

Chapter 2 provides an overview of deaths due to pedal cyclist injury.

Chapter 3 focuses on hospitalised pedal cyclist injury within the context of all serious land transport-related injury.

Chapter 4 reports on the characteristics and outcomes of pedal cyclist injury hospitalisations with respect to whether they occurred on- or off-road.

Chapter 5 reports on the injuries sustained in pedal cycle related hospitalisations: their nature and severity and the major body region affected.

Chapter 6 discusses the changing age profile of injured pedal cyclists over time and the implications this has for the relative priority of this group of land transport users with respect to prevention and cost to the community.

Appendix A: Data issues provides summary information on the National Hospital Morbidity Database (NHMD) and the AIHW National Mortality Database, notes on the presentation of data, the population estimates used to calculate population rates, and analysis methods.

Appendix B: Participation data provides information regarding the participation of Australians in cycling over time. This information is derived from the surveys referred to earlier in this chapter.

Appendix C: Other cases with mention of cycling provides information on NHMD records that do not have an external cause code for pedal cyclist injury in land transport accidents, but do have an activity code related to cycling. Specifically, the codes U66.0, *Cycling* and U67.40, *Cycling event* (as part of a triathlon) identify cases of cycling-related hospitalisation.

Supplementary tables in the form of an online spreadsheet, provide the data that were used to produce the figures that appear in the body of the report.

Methods

Which hospitalisations and deaths were included?

Hospitalisations

Hospitalisations were regarded as being due to pedal cyclist injury and included in this report if they met the following selection criteria:

- hospital separations that occurred in Australia between 1 July 1999 to 30 June 2016
- had a principal diagnosis in the ICD-10-AM range S00–T75 or T79 using Chapter XIX *Injury, poisoning and certain other consequences of external causes* codes
- the first reported external cause code was in the range V10–V19 (*Pedal cyclist injured in transport accident*)
- the record did not contain the code Z50 *Care involving use of rehabilitation procedures* in any of the diagnosis fields
- mode of admission was not a transfer from another acute hospital.

The codes are from the *International statistical classification of diseases and related health problems, 10th revision, Australia modification* (ICD-10-AM).

Prior to finalising the selection criteria for cases, a subset of hospital separations for the period 1999–00 to 2015–16 was created by selecting all records where the first reported external cause code was outside the range V10–V19 but the record did have the activity code U66.0, *Cycling*. 4,684 records meeting these criteria were identified. These records were reviewed in order to gain an insight into the nature of these cases. The results of this analysis appear in Appendix C: Other cases with mention of cycling.

Deaths

Deaths were regarded as being due to pedal cyclist injury and included in this report if they met the following selection criteria:

- deaths that occurred in Australia between 1 July 1999 and 30 June 2016
- the underlying cause of death (UCoD) was in the ICD-10 range V10–V19 (*Pedal cyclist injured in transport accident*).

Further information

In tables and charts, unless stated otherwise:

- the patient's age is as at the date of admission or death
- rates were calculated using Estimated Resident Populations (ERP) for the mid-point of each year to 30 June. All-ages rates were age-standardised as detailed in Appendix A: Data issues
- trends in rates over time were estimated by fitting negative binomial models to age-adjusted case numbers (Berry & Harrison 2006). See also Appendix A.

Important terms relating to the data used in this report are summarised in boxes 1.1 to 1.3, and further information on data and methods is provided in Appendix A.

Box 1.1: Summary of terms relating to hospitalised injury

Statistics on admitted patients are compiled when an **admitted patient** (a patient who undergoes a hospital's formal admission process) completes an episode of admitted patient care and 'separates' from the hospital. This is because most of the data on the use of hospitals by admitted patients are based on information provided at the end of the patients' episodes of care, rather than at the beginning. The length of stay and procedures carried out are then known, and the diagnostic information is more accurate.

Separation is the term used to refer to the episode of admitted patient care, which can be a total hospital stay (from admission to discharge, transfer, or death) or a portion of a hospital stay beginning or ending in a change of type of care (for example, from acute care to rehabilitation). 'Separation' also means the process by which an admitted patient completes an episode of care by being discharged, dying, transferring to another hospital, or changing type of care.

The **principal diagnosis** is the diagnosis established after study to be chiefly responsible for occasioning the patient's episode of admitted patient care.

An **external cause** is defined as the environmental event, circumstance, or condition that was the cause of injury or poisoning. Whenever a patient has a principal or additional diagnosis of an injury or poisoning, an external cause code should be recorded.

The **injury separation records** included in this report are those that have a principal diagnosis code in the ICD-10-AM range S00–T75 or T79. Whenever a patient has a principal or additional diagnosis of an injury or poisoning, an external cause code should be recorded. This includes records where the main reason for the episode in hospital was a recent injury, such as a fracture, laceration or burn to any part of the body, or poisoning. It also includes a small number of episodes mainly due to complications of surgical and medical care, or due to sequelae present a year or more after injury, or other late effects.

Records are included if they were caused unintentionally ('accidents'). While a cyclist could be injured intentionally, ICD-10 and ICD-10-AM do not enable such cases to be distinguished. Throughout this report, records with a principal diagnosis of S00–T75 or T79 are included in the totals of tables unless otherwise indicated, even if they lack an external cause, or if they have a first-reported external cause code of complications of surgical and medical care, or codes describing the sequelae of external causes. These records meet the principal diagnosis definition of community injury, but lack a meaningful external cause.

Injury cases are estimated as the number of injury separations, minus those records where the mode of admission was 'inward transfer'. Inward transfers are omitted to reduce over-counting, as are records containing code Z50 *Care involving use of rehabilitation procedures*.

The criteria for injury cases retain a small number of records with a first external cause code that is invalid or refers to a sequelae (late effect) or complication of care. These cases are reported as 'other or missing' in tables of external causes.

The **mean length of stay** is the average number of days each patient stayed in hospital during an included episode of care. This was calculated by dividing the total number of patient days for **injury separations** by the number of **injury cases**. Patients who were admitted and discharged from hospital on the same day are counted as staying for 1 day.

Injuries can be classified according to the likelihood that a patient with that injury will die in hospital. The method used refers to cases with a predicted mortality risk of about 6% or higher as having a **high threat to life** (Stephenson et al. 2004). Injuries of this severity are likely to have a large impact on the patient, often with persisting problems and ongoing need for health-care services.

Box 1.2: Summary of terms relating to injury deaths

An **external cause** is the environmental event, circumstance, or condition that was the cause of injury or poisoning. For injury deaths, the **underlying cause of death** is a code representing the external cause of the injury that initiated the train of morbid events leading directly to a person's death, according to information available to the coder.

The diseases or conditions recorded on the death certificate consist of:

- the cause that led directly to the death
- the causes that gave rise to the underlying cause of death
- the causes of death that contributed to the death, but were not related to the disease or condition causing it.

Coding is according to the International Classification of Diseases, 10th revision (ICD-10), which includes a chapter for injury, and another for external causes of injuries and other conditions. Rules that form part of the ICD determine which cause should be coded as the underlying cause of death and that for injury deathsit must be the external cause.

Box 1.3: Summary of terms relating to land transport

Land transport refers to all modes of transport except air, water, and space.

Cases of land transport-related injury with ICD-10 or ICD-10-AM external cause codes indicating that they occurred in traffic are included in this report as **on-road** crash cases. This group of cases usually happen on public roads and streets.

A second group of land transport cases have an ICD-10 or ICD-10-AM external cause code indicating that they were non-traffic crashes. In this report, this group is referred to as **off-road** crash cases. These cases occur entirely in any place other than a public road or street.

If it is not known to the coder whether an event injuring a pedal cyclist occurred in traffic (on-road), or was a non-traffic event (off-road), then an ICD-10 and ICD-10-AM instruction is to code incidents where the mode of transport was a pedal cycle as having happened in traffic (on-road).

A detailed list of the codes used to select cases for the **on-road** crashes and **off-road** crashes groups can be found in Appendix A.

The **Counterpart** in a pedal cycle crash refers to the vehicle, person, or object that struck, or was struck by, the bicycle. In some cases (for example, where the injury resulted from a cyclist falling from their bicycle), the counterpart is recorded as a '**non-collision**' event.

Participation data for pedal cyclists, also referred to as exposure data, provides estimates of the number of people who ride bicycles. Some participation data are limited to estimates of the number of people who have ridden a bicycle at least once during a given period, while other estimates also include more detailed information about the frequency of use and the distances travelled (see Appendix B). Participation data were not sufficient to allow calculation of participation-based injury rates.

2 Deaths of cyclists from their injuries

Annual numbers of pedal cyclist injury deaths fluctuate, so it is preferable to rely on annual averages derived from cases that occurred over a longer period.

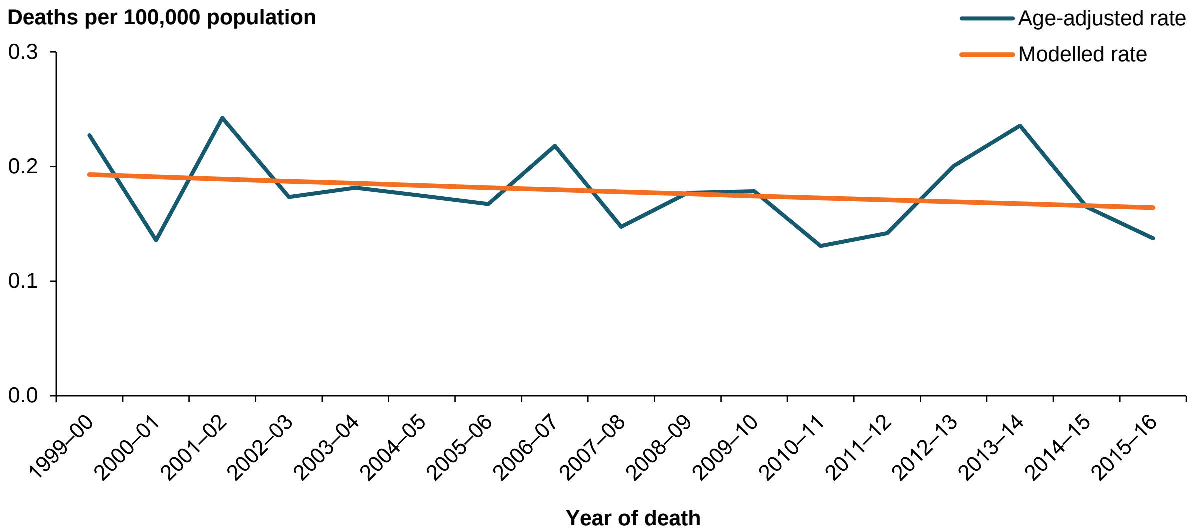
In the 17 years from 1999–00 to 2015–16, 651 pedal cyclists died in cycling crashes—an average of about 38 deaths per year. Of these fatally injured cyclists:

- nearly 9 in 10 were male
- nearly 8 in 10 were aged 25 or over
- half involved a person aged 45 or over
- 90% were the result of an on-road crash.

How has the number of deaths changed over time?

Cyclist death rates (after adjusting for age) fluctuated over the 17 years (Figure 2.1). Modelling suggests a slight downward trend of 1% per year over the period, although this was not statistically significant (95% CI: –2.82 to 9.73).

Figure 2.1: Age-adjusted and modelled rates of cyclist deaths, 1999–00 to 2015–16



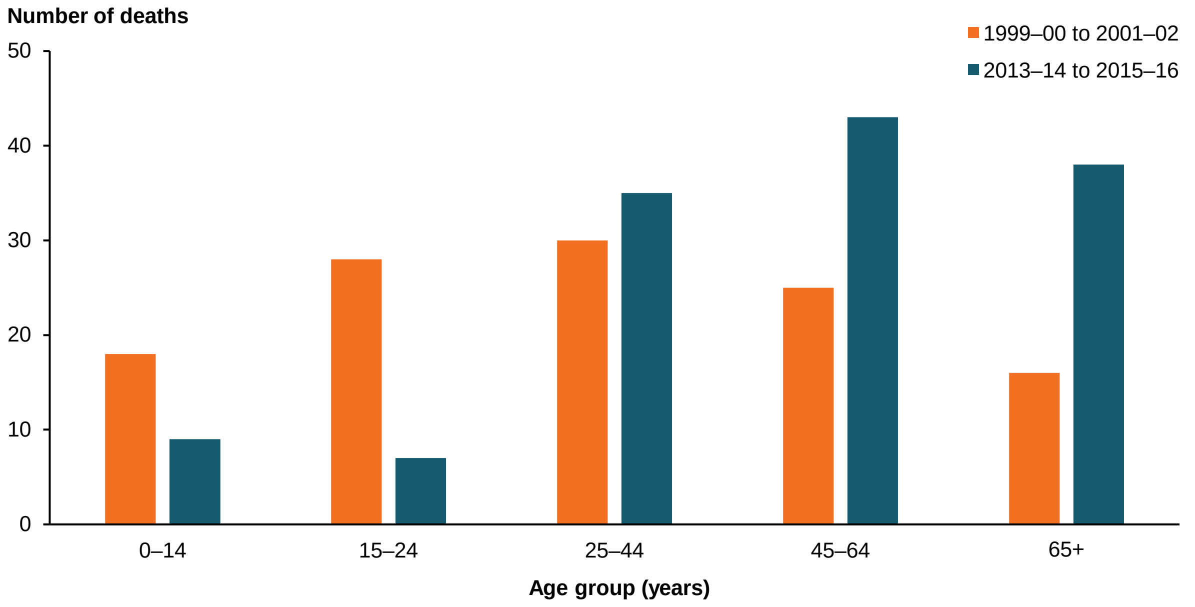
Note: Data for this figure are available in Supplementary table S2.1.

Source: AIHW National Mortality Database.

Although rates of death remained fairly stable, the age at which fatally injured cyclists died changed noticeably over the 17-year period from 1999–00 to 2015–16 (Figure 2.2).

The number and proportion of fatally injured cyclists aged 45 and over nearly doubled, from 35% of deaths for the first 3 years to 61% in the last 3 years. By contrast, the proportion of deaths involving cyclists under the age of 25 fell substantially, from 39% in the first 3 years to 12% in the last 3 years.

Figure 2.2: Cyclist deaths, by age, 1999–00 to 2001–02 and 2013–14 to 2015–16



Note: Data for this figure are available in Supplementary table S2.2.

Source: NMD.

What injuries were sustained?

During the 3 years from 2013–14 to 2015–16, in nearly half of cyclist deaths (48%), the head and neck was the main area injured. In about 4 in 10 deaths, the cyclist had sustained injuries to multiple parts of their body (38%).

Where did the deaths occur?

During the 3 years from 2013–14 to 2015–16, nearly 9 in 10 (88%) deaths occurred on-road.

3 Hospitalisations of cyclists and other land transport users

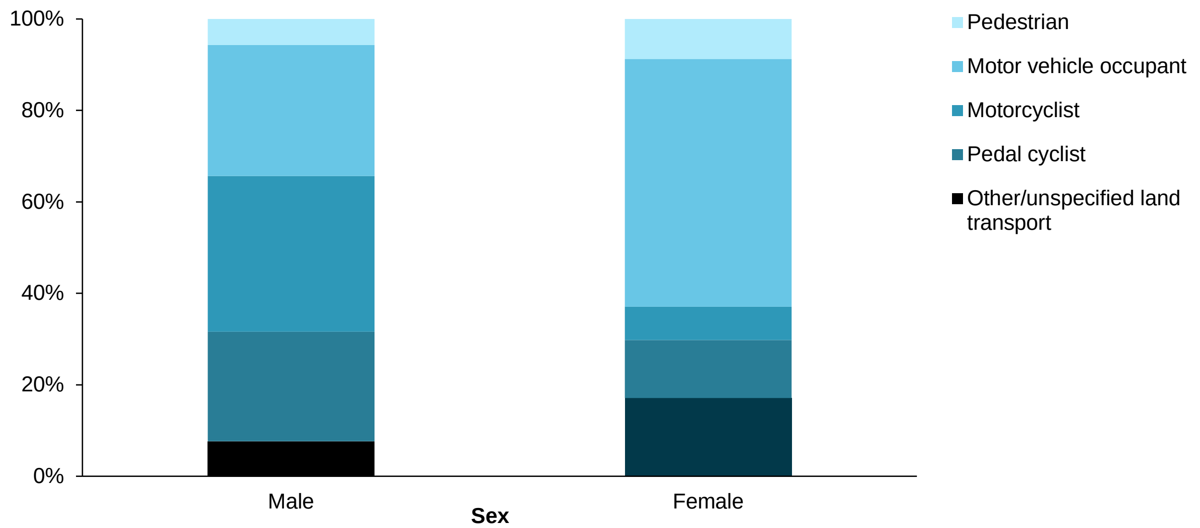
In 2015–16, about 60,000 people were hospitalised in Australia after being injured in a land transport crash. A large proportion of these cases involved motor vehicle occupants (37%), but motorcyclists (25%) and pedal cyclists (20%) also made up sizeable proportions (Figure 3.1).

This chapter describes the scale, and selected characteristics, of cyclist hospitalisations compared with other forms of land transport. Later chapters go into greater depth on the cyclist cases.

What was the sex and age of hospitalised land transport users?

Males were more likely than females to be hospitalised from a cycling crash. In 2015–16, nearly 1 in 4 males hospitalised after a land transport crash were cyclists, compared with 1 in 8 females.

Figure 3.1: Hospitalised cases of land transport-related injury, by type of land transport user and sex, 2015–16

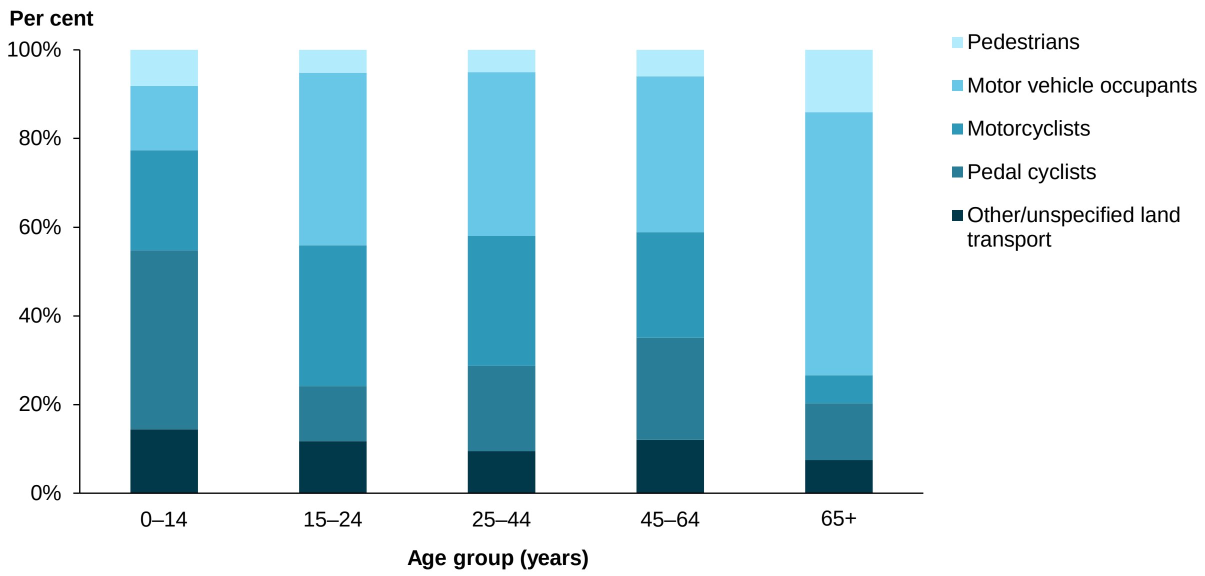


Note: Data for this figure are available in Supplementary table S3.1.

Source: NHMD.

The proportion of land transport hospitalisations that involved pedal cyclists varied according to age. In 2015–16, pedal cyclists were most prominent among land transport crashes involving children aged up to 14 (about 4 in 10 cases). Pedal cyclists amounted to over one-fifth of hospitalisations from land transport crashes at ages 45–64 (Figure 3.2). Chapter 6 details variation of pedal cyclist cases with age and over time.

Figure 3.2: Hospitalised cases of land transport-related injury, by type of land transport user and age, 2015–16



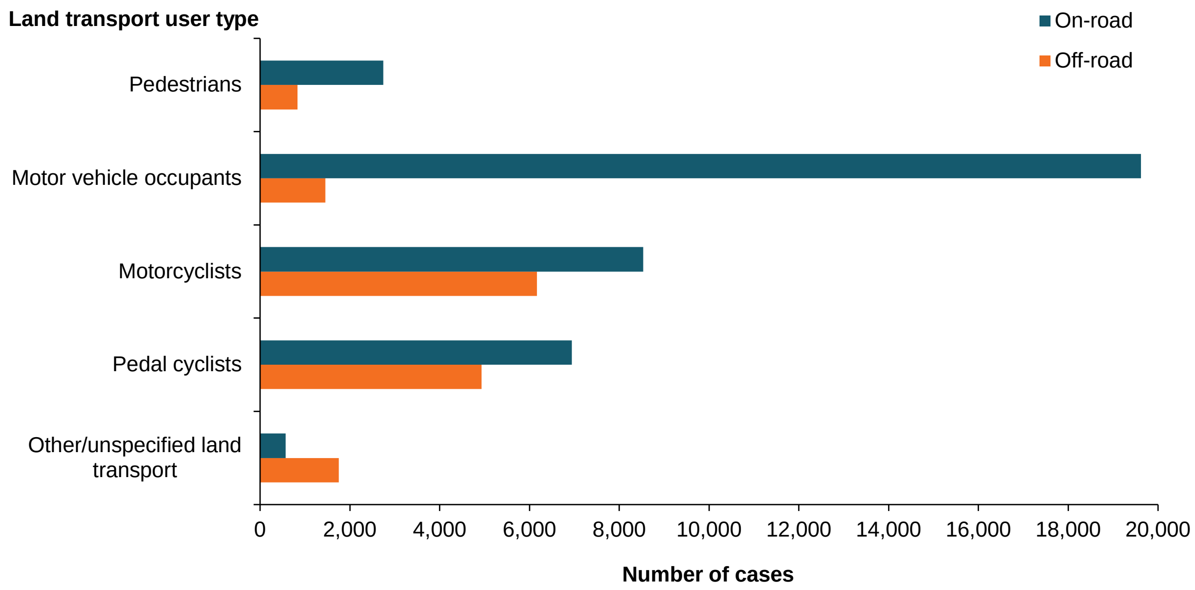
Note: Data for this figure are available in Supplementary table S3.2.

Source: NHMD.

Did the crashes occur on-road or off-road?

About 4 in 10 cases involving pedal cycles (41%) and motorcycles (41%) occurred off-road (Figure 3.3). This compares with about 2 in 10 pedestrians (21%), and contrasts particularly with motor vehicle occupants injured off-road (7%). Chapter 4 provides a more detailed comparison of on-road and off-road pedal cyclist cases. Box 1.3 provides information about the coding of cases as on-road or off-road.

Figure 3.3: Hospitalised cases of land transport-related injury, by on-road/off-road status, 2015–16



Note: Data for this figure are available in Supplementary table S3.3.

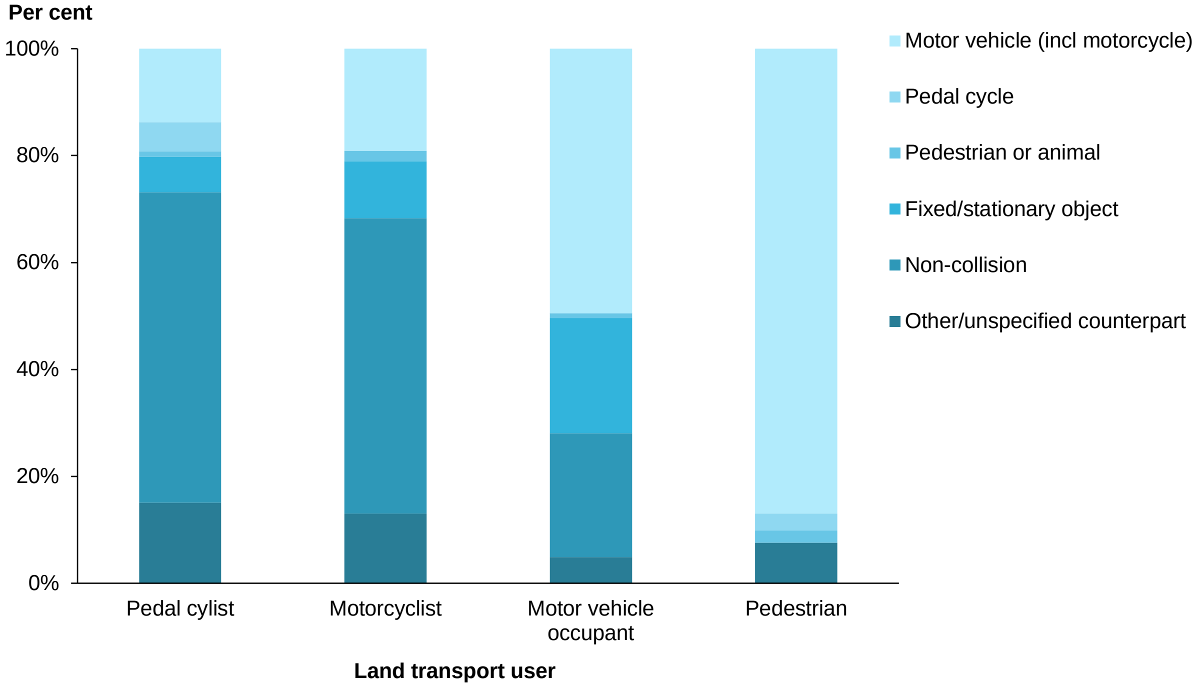
Source: NHMD.

What were the counterparts in land transport crashes?

The type of counterpart involved in a crash varied according to the category of land transport user (Figure 3.4). The patterns for pedal cyclists (58% of cases) and motorcyclists (55%) were similar in that the highest proportion of crashes did not involve a collision. Non-collision crashes include circumstances such as falling from a bicycle. For pedal cyclists, in a small but noteworthy proportion of cases, the counterpart in the crash was another pedal cyclist (5% of cases).

In half of the cases that involved a motor vehicle occupant, the injury had occurred in a collision with another motor vehicle. In nearly 9 in 10 of the cases that resulted in the hospitalisation of a pedestrian (87%), the person had been struck by a motor vehicle. In 3% of cases, a pedestrian had been struck by a pedal cycle.

Figure 3.4: Hospitalised cases of land transport-related injury, by type of counterpart involved in the crash, 2015–16



Note: Data for this figure are available in Supplementary table S3.4.

Source: NHMD.

What injuries were sustained?

The admitted patient cases in this report all have an injury as the principal diagnosis.

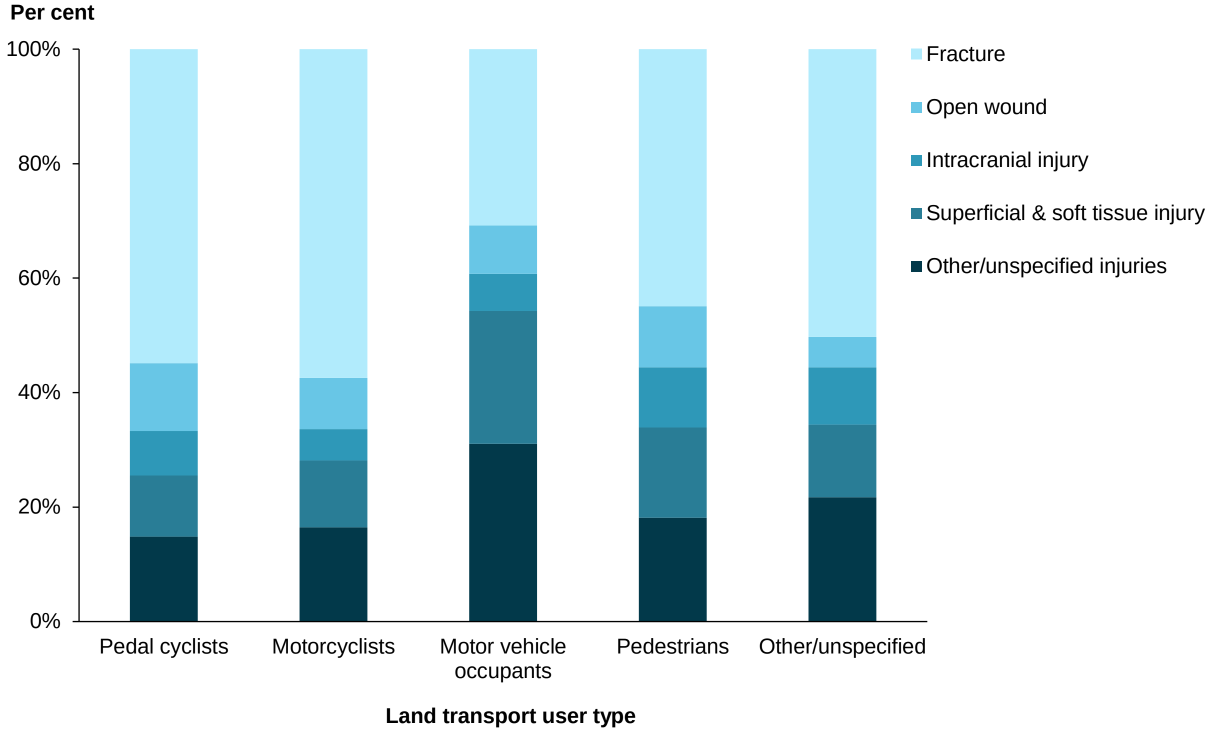
While fractures were the most common type of injury for all hospitalised land transport users, the prominence of this type of injury varied between transport user groups (Figure 3.5).

For nearly 6 in 10 pedal cyclists (55% of cases) and motorcyclists (57%), a fracture was the major injury, compared with 3 in 10 motor vehicle occupants (31%).

Pedestrians had the highest proportion of intracranial injury (11%), but the proportion for pedal cyclists was only slightly lower (8%). The lowest proportion of intracranial injuries was for motorcyclists (6%).

The proportion of motor vehicle occupants who were hospitalised for a superficial or soft tissue injury (23%) was double that for pedal cyclists (11%).

Figure 3.5: Hospitalised cases of land transport-related injury, by type of injury, 2015–16

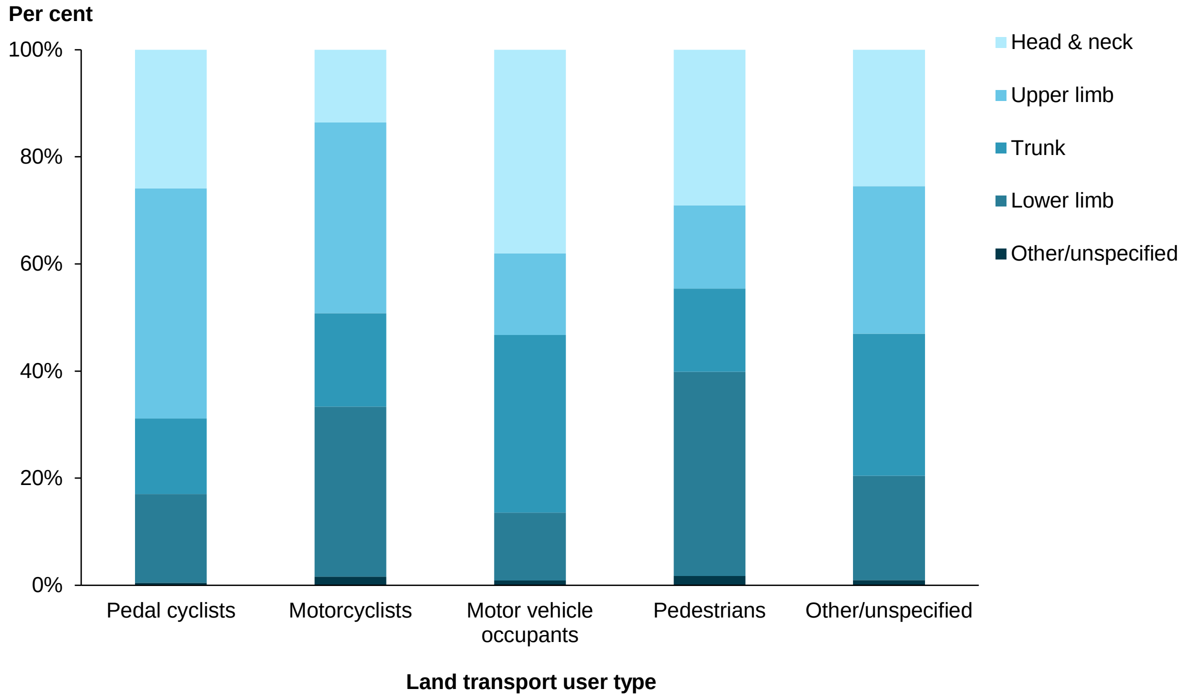


Note: Data for this figure are available in Supplementary table S3.5.

Source: NHMD.

The most commonly injured body region for pedal cyclists was an upper limb (43%) (Figure 3.6). This contrasted with motor vehicle occupants and pedestrians for whom this was the main body part injured in only 16% of cases. Motor vehicle occupants had the highest proportion of injuries involving the head and neck (38%), but this part of the body was also commonly affected in pedal cyclists (26%).

Figure 3.6: Hospitalised cases of land transport-related injury, by principal body region affected, 2015–16



Note: Data for this figure are available in Supplementary table S3.6.

Source: NHMD.

How serious were the injuries?

Compared with other types of land transport users, pedal cyclists had the lowest proportion of cases in which their injuries posed a high threat to life. Exceptions to this were the 2 oldest age groups, for which the proportions of cyclists with life-threatening injuries were similar to, or in some cases higher than, those for other types of land transport user.

Table 3.1 summarises threat to life and other indicators of severity for each of the main land transport user groups. Across all age groups, pedal cyclists had the lowest mean length of stay in hospital after being injured. Motorcyclists, motor vehicle occupants, and pedestrians were more likely than pedal cyclists to have been transferred to another acute care facility, suggesting that their injuries were more severe.

Table 3.1: Indicators of severity for hospitalised cases of land transport-related injury, by type of land transport user, 2015–16

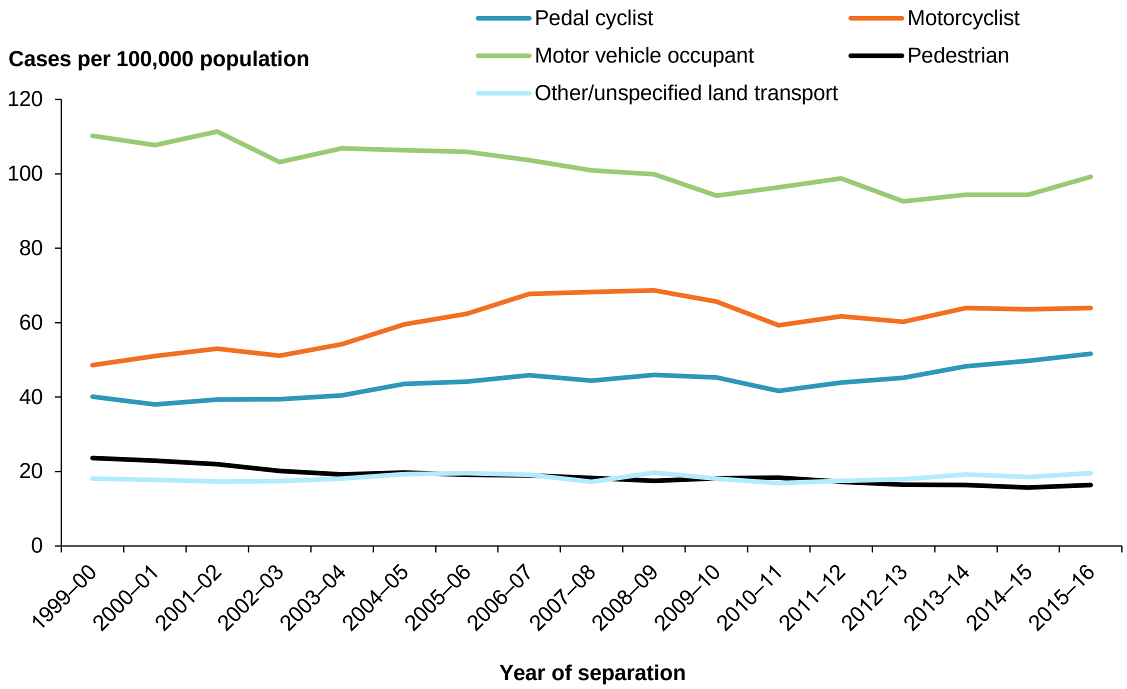
Land transport user type	Age group (years)	Cases (no.)	Mean length of stay (days)	High threat to life (%)	Transferred to another acute care facility (%)
Pedal cyclists	0–4	260	1.5	2.7	6.2
	5–14	2,360	1.6	8.1	7.8
	15–24	1,611	1.9	14.7	6.4
	25–44	3,676	2.2	18.2	5.8
	45–64	3,174	2.7	29.8	8.2
	65+	946	4.4	43.2	18.4
	All ages	**12,027**	**2.3**	**20.4**	**7.9**
Motorcyclists	0–4	49	1.8	8.2	14.3
	5–14	1,416	2.3	12.7	13.1
	15–24	4,098	3.1	19.3	10.6
	25–44	5,606	3.9	22.2	11.4
	45–64	3,270	4.9	32.0	15.3
	65+	470	6.9	42.8	20.2
	All ages	**14,909**	**3.8**	**23.2**	**12.5**
Motor vehicle occupants	0–4	257	4.3	19.8	8.7
	5–14	686	2.7	17.2	9.2
	15–24	5,033	2.9	22.5	12.3
	25–44	7,079	3.1	22.1	11.8
	45–64	4,844	3.9	24.4	13.2
	65+	4,398	5.6	31.0	28.4
	All ages	**22,297**	**3.7**	**24.3**	**14.9**
Pedestrians	0–4	159	3.0	27.7	10.7
	5–14	370	3.4	24.6	10.0
	15–24	665	3.9	28.9	9.3
	25–44	962	4.6	28.9	10.1
	45–64	820	6.2	29.6	15.2
	65+	1,040	8.5	38.0	29.2
	All ages	**4,016**	**5.6**	**31.0**	**16.0**

Source: NHMD.

How have land transport injury hospitalisations changed over time?

Despite year-to-year fluctuations, age-adjusted population-based rates of hospitalisation for pedal cyclists and motorcyclists rose, while they fell for motor vehicle occupants and pedestrians (Figure 3.7).

Figure 3.7: Age-adjusted rates of land transport-related injury hospitalisation, by type of land transport user, 1999–00 to 2015–16



Note: Data for this figure are available in Supplementary table S3.7.

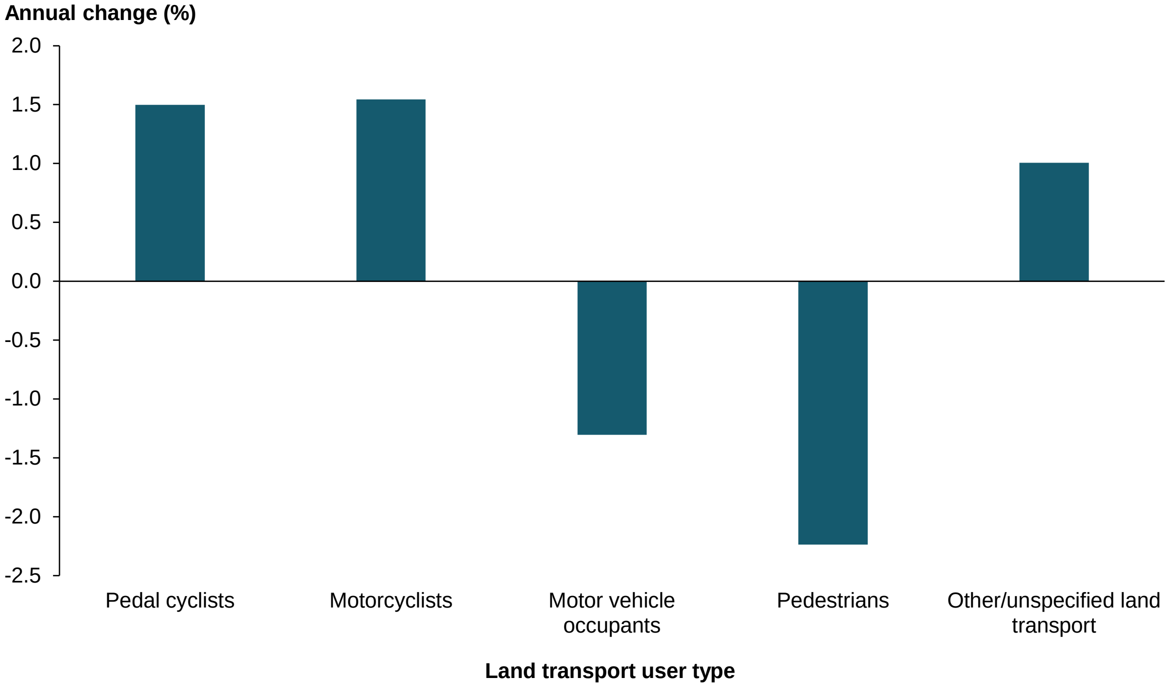
Source: NHMD.

Trends over the 17-year period shown in Figure 3.7 can be summarised by building a model around the age-adjusted annual rates, and calculating the average percentage change per year (Figure 3.8) (see Appendix A for more information on the method used).

Over the whole period, pedal cyclists and motorcyclists each showed an upward trend, with an average rise of 1.5% per year (95% CI: 1.1%–1.9% for pedal cyclists, 0.8%–2.3% for motorcyclists).

In contrast, the trend was downward for motor vehicle occupants, with a fall of 1.3% (95% CI: –1.0% to –1.6%), and for pedestrians, with a fall of 2.2% per year (95% CI: –1.9% to –2.6%). Further information on trends over time in hospitalised injury of pedal cyclists is provided in chapters 4 and 6.

Figure 3.8: Annual change in age-adjusted rates of land transport-related injury hospitalisation, by type of land transport user, 1999–00 to 2015–16



Note: Data for this figure are available in Supplementary table S3.8.

Source: NHMD.

4 Pedal cyclists injured off-road and on-road

Routinely collected hospitalisation and death data are important sources of information about the extent of serious pedal cyclist injury. There are also official data collections that aim to measure the magnitude of injury due to road crashes, including those involving pedal cycles. Data on fatal and non-fatal crashes are collected by state and territory agencies, and used to inform the development of policy and plans aimed at improving road safety.

Data linkage studies using hospitalisations data and crash data, in Australia and elsewhere, have found that a large proportion of injurious pedal cycle road crashes are not included in official crash data collections (Austroads Ltd 2019; Cryer et al. 2001; Langley et al. 2003a; Loo & Tsui 2007; Lujic et al. 2008; Watson et al. 2015).

As the focus of most crash data collections is on-road events, the availability of information on off-road pedal cycle crashes is even poorer. But, as shown in this report, off-road crashes account for a sizeable proportion of all hospitalised pedal cyclist injury cases.

In 2015–16, of the 12,027 people who were hospitalised as the result of a pedal cyclist injury, 58% were reported as being injured in a road crash, and 41% in an off-road crash. In 1% of cases, the cause code does not specify whether the incident occurred on-road or off-road.

Further information on coding of cases as off-road and on-road is given in Box 1.3.

What was the age and sex of hospitalised cyclists?

Males accounted for the majority of hospitalised pedal cyclist injury cases, both on-road and off-road (Table 4.1). They comprised a slightly higher proportion of off-road (81%) than on-road cases (78%).

Table 4.1: Hospitalised cases of pedal cyclist injury, by sex and on-road/off-road status, 2015–16

	On-road			Off-road			Total[(a)]
Sex	**Number**	**%**	**Adjusted rate**	**Number**	**%**	**Adjusted rate**	**Number**
Males	5,388	77.6	46.0	3,969	80.5	34.7	9,357
Females	1,555	22.4	13.0	964	19.5	8.3	2,519
Persons	**6,943**	**100.0**	**29.4**	**4,933**	**100.0**	**21.6**	**11,876**

(a) The total does not include cases for which it was not specified whether they occurred on- or off-road (n = 151).

Source: NHMD.

In the most recent year, cyclists in off-road crashes tended to be younger than those involved in on-road crashes. Almost 3 in 4 (74%) of those in off-road crashes were aged under 45, compared with 60% of those in on-road crashes (Table 4.2).

Table 4.2: Hospitalised cases of pedal cyclist injury, by age group and on-road/off-road status, 2015–16

	On-road			Off-road			Total(a)
Age group (years)	**Number**	**%**	**Adjusted rate**	**Number**	**%**	**Adjusted rate**	**Number**
0–4	57	0.8	3.6	197	4.0	12.6	254
5–14	942	13.6	32.2	1,396	28.3	47.4	2,338
15–24	835	12.0	26.6	765	15.5	25.0	1,600
25–44	2,328	33.5	34.4	1,308	26.5	19.4	3,636
45–64	2,147	30.9	36.9	980	19.9	16.9	3,127
65+	634	9.1	17.4	287	5.8	7.9	921
All ages	**6,943**	**100.0**	**29.4**	**4,933**	**100.0**	**21.6**	**11,876**

(a) The total does not include cases for which it was not specified whether they occurred on- or off-road (*n* = 151).

Source: NHMD.

What were the counterparts in pedal cycle crashes?

Being injured in a non-collision event was the most common scenario for hospitalised pedal cyclists, whether they were injured on-road or off-road (Table 4.3). But crashes that did not involve a collision were nearly twice as common among off-road cases (80%) as on-road cases (44%).

The second most prominent counterpart in on-road pedal cyclist cases was a motor vehicle (23%). This contrasted starkly with off-road pedal cycle crashes, where a motor vehicle was the counterpart in only 1% of cases.

Table 4.3: Hospitalised cases of pedal cyclist injury, by type of counterpart in crash and on-road/off-road status, 2015–16

	On-road		Off-road		Total(a)
Counterpart in crash	**Number**	**%**	**Number**	**%**	**Number**
Motor vehicle (including motorcycles)	1,601	23.1	52	1.1	1,653
Pedestrian or animal	86	1.2	39	0.8	125
Pedal cycle	354	5.1	295	6.0	649
Fixed/stationary object	395	5.7	405	8.2	800
Non-collision	3,029	43.6	3,927	79.6	6,956
Other/unspecified counterpart	1,478	21.3	215	4.4	1,693
All counterparts	**6,943**	**100.0**	**4,933**	**100.0**	**11,876**

(a) The total does not include cases for which it was not specified whether they occurred on- or off-road (*n* = 151).

Source: NHMD.

How serious were the injuries?

Across all ages, a slightly larger proportion of the injuries sustained in on-road crashes (23%) posed a high threat to life than those sustained off-road (18%) (Table 4.4).

On-road cyclist injury cases resulted in a slightly longer mean length of stay (2.5 days) in hospital than off-road cyclist injury cases (2.1 days). Whether the injury occurred on-road or off-road, similar proportions of hospitalised cyclists overall were transferred to another acute care facility.

Severity generally increased with age. For both on-road and off-road cases, when compared with their younger counterparts, cyclists aged 45 and over:

- had a longer mean length of stay
- were more likely to have life-threatening injuries
- were more often transferred to another hospital.

Table 4.4: Hospitalised cases of pedal cyclist injury, by indicators of severity and on-road/off-road status, 2015–16

On-road/off-road status	Age group (years)	Cases	Mean length of stay (days)	High threat to life (%)	Transferred to another acute care facility (%)
On-road	0–4	57	1.4	1.8	5.3
	5–14	942	1.6	8.8	6.7
	15–24	835	1.8	14.7	5.6
	25–44	2,328	2.2	18.3	4.7
	45–64	2,147	2.9	30.7	8.0
	65+	634	4.6	43.4	19.1
	All ages	**6,943**	**2.5**	**22.6**	**7.4**
Off-road	0–4	197	1.5	3.0	6.6
	5–14	1,396	1.6	7.4	8.7
	15–24	765	2.0	14.9	7.3
	25–44	1,308	2.1	18.3	8.0
	45–64	980	2.3	27.7	8.8
	65+	287	4.1	43.9	17.4
	All ages	**4,933**	**2.1**	**17.5**	**8.7**

Source: NHMD.

Where did the crashes occur?

The Place of Occurrence item provides further insight into pedal cyclist on-road and off-road crashes (Table 4.5).

In 2015–16, as would be expected, the most common place of occurrence for hospitalised on-road pedal cyclist cases was a street or highway (69%).

Nearly all of the remaining on-road cases lacked information on place of occurrence. It would be consistent with an ICD-10-AM coding rule for these cases to have been assigned traffic (that is, on-road) status by default. The rule instructs coders to assume that pedal cyclist cases (and those involving users of most other types of land transport) occurred on a public highway if the record available to the coder lacks information on where the crash occurred. As place of occurrence is unspecified in these cases, it is likely that the defaulting rule accounts for them being assigned a traffic (on-road) external cause code. A recent Australian study based on record linkage did not include most cases of this type in estimates of non-fatal road injury, due to the degree of doubt as to whether they had occurred on-road (Austroads Ltd 2019).

For off-road pedal cycle crashes, the most common places of occurrence were street and highway (19%), indoor or outdoor sporting facilities (15%), and farm or countryside (12%) (Table 4.5). A place of occurrence was not specified in 42% of off-road cases.

While the combination of an off-road external cause code with a street and highway place code appears incongruous, the combination could be correct. For example, cases occurring on footpaths, nature strips, pedestrian refuges, and other road-related areas might not be seen as having occurred in traffic (on-road), but these places are part of a street or highway.

Table 4.5: Hospitalised cases of pedal cyclist injury, by place of occurrence and on-road/off-road status, 2015–16

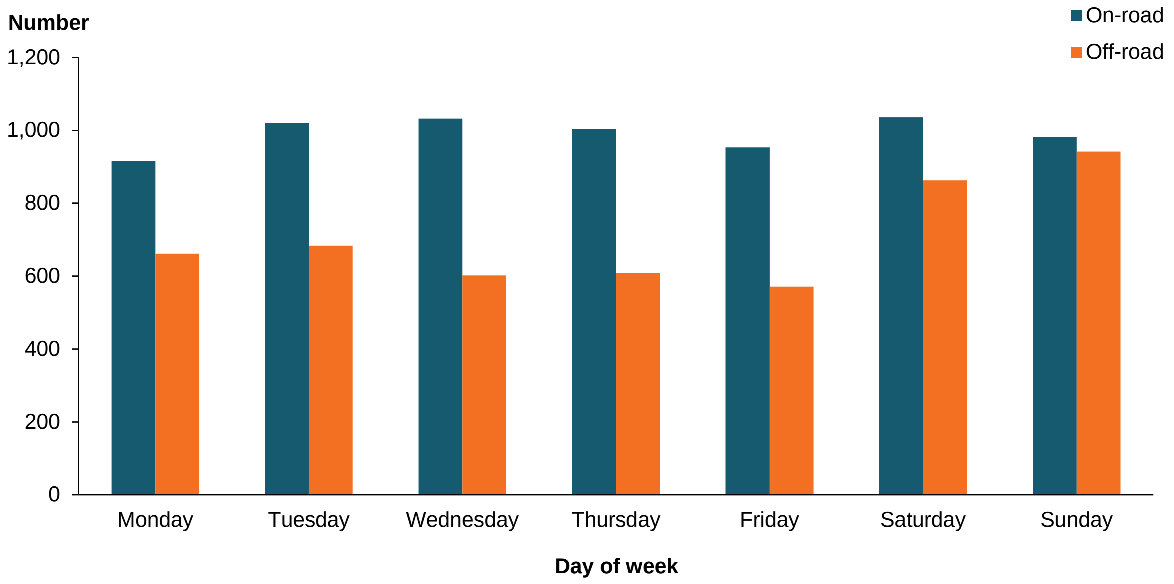
	On-road		Off-road	
Place of occurrence	**Number**	**%**	**Number**	**%**
Street and highway				
Footpath	92	1.3	159	3.2
Cycleway	117	1.7	127	2.6
Other specified public highway	782	11.3	179	3.6
Unspecified public highway	3,789	54.6	482	9.8
Total street and highway	*4,780*	*68.8*	*947*	*19.2*
Driveway or other part of home	21	0.3	236	4.8
Sports facility	62	0.9	713	14.5
Farm or countryside	51	0.7	601	12.2
Other specified place of occurrence	99	1.4	364	7.4
Unspecified place of occurrence	1,930	27.8	2,072	42.0
Total	**6,943**	**100.0**	**4,933**	**100.0**

Source: NHMD.

On what days of the week did crashes occur?

On-road case numbers varied little with day of week. In contrast, off-road cases were more numerous on weekends than on weekdays (Figure 4.1).

Figure 4.1: Hospitalised cases of pedal cyclist injury, by day of week on which the crash occurred, 2015–16



Note: Data for this figure are available in Supplementary table S4.1.

Source: NHMD.

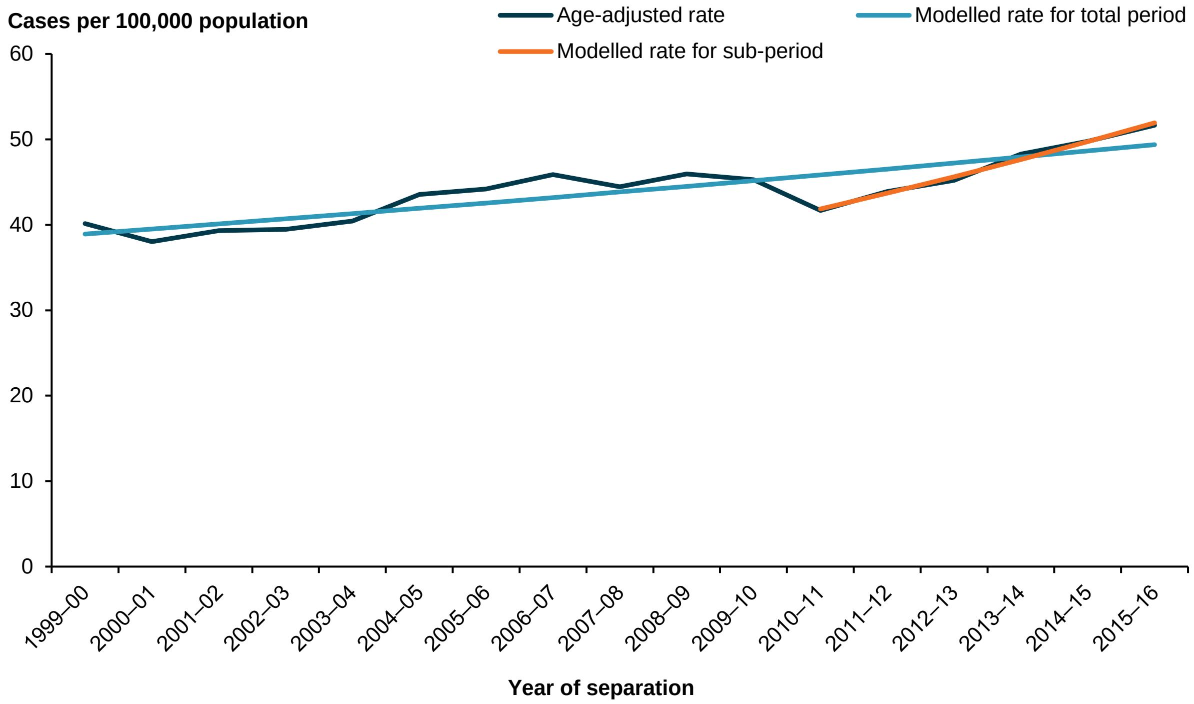
How has the pattern of on-road and off-road crashes changed over time?

The on-road/off-road status of hospitalised pedal cyclist injury has changed markedly over time.

The overall rate of hospitalisation due to pedal cyclist injury rose between 1999–00 and 2015–16 (figures 3.7 and 4.2), but trends fluctuated.

Figure 4.2 shows the age-adjusted rates and the modelled trend. The modelled trend for the whole period shows an average rate rise of 1.5% per year (95% CI: 1.09%–1.90%). But the rise over the more recent 6-year period (2010–11 to 2015–16) was more rapid, at 4.4% per year (95% CI: 3.9%–4.9%).

Figure 4.2: Age-adjusted rates and modelled trends for pedal cyclist injury hospitalisation, 1999–00 to 2015–16 and 2010–11 to 2015–16



Note: Data for this figure are available in Supplementary table S4.2.

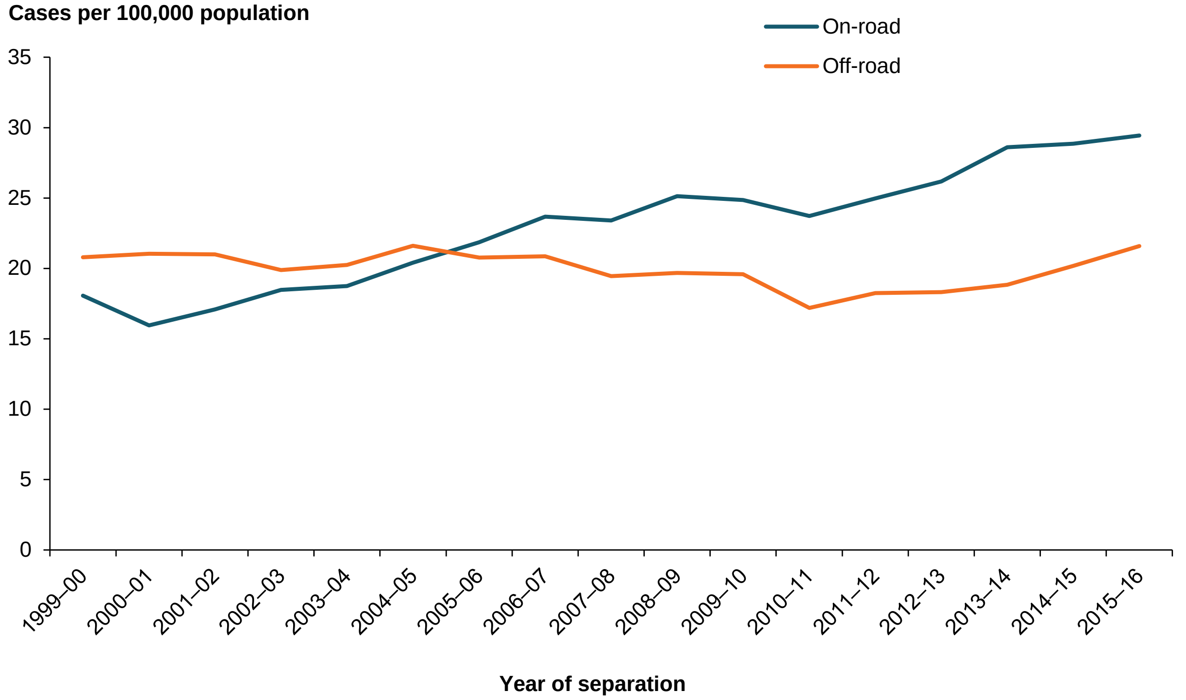
Source: NHMD.

Trends have differed for on-road and off-road cases. From 1999–00 to 2015–16, rates for on-road pedal cyclist cases have overtaken those for off-road cases (Figure 4.3).

Over the full period, the modelled trend estimates that on-road pedal cyclist cases rose by an average of 3.7% per year (95% CI: 3.18%–4.18%), while off-road cases fell by 0.5% per year (95% CI: 0% to –1.1%) (Figure 4.4).

During the most recent 6 years, 2010–11 to 2015–16, trends were similar for the 2 groups, with rate increases of 4.7% per year for on-road cases (95% CI: 3.7%–5.6%) and 4.3% for off-road cases (95% CI: 3.4%–5.3%) (Figure 4.4).

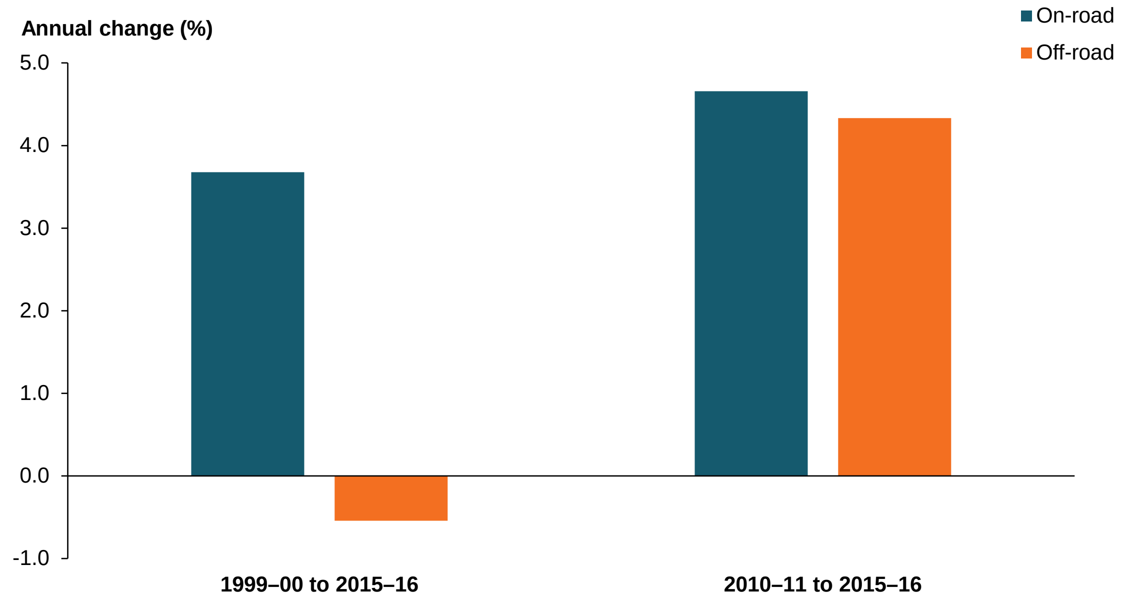
Figure 4.3: Age-adjusted rates of pedal cyclist injury hospitalisation, by on-road/off-road status, 1999–00 to 2015–16



Note: Data for this figure are available in Supplementary table S4.3.

Source: NHMD.

Figure 4.4: Annual change in age-adjusted rates of pedal cyclist injury hospitalisation, by on-road/off-road status, 1999–00 to 2015–16 and 2010–11 to 2015–16



Note: Data for this figure are available in Supplementary table S4.4.

Source: NHMD.

5 Injuries sustained by pedal cyclists

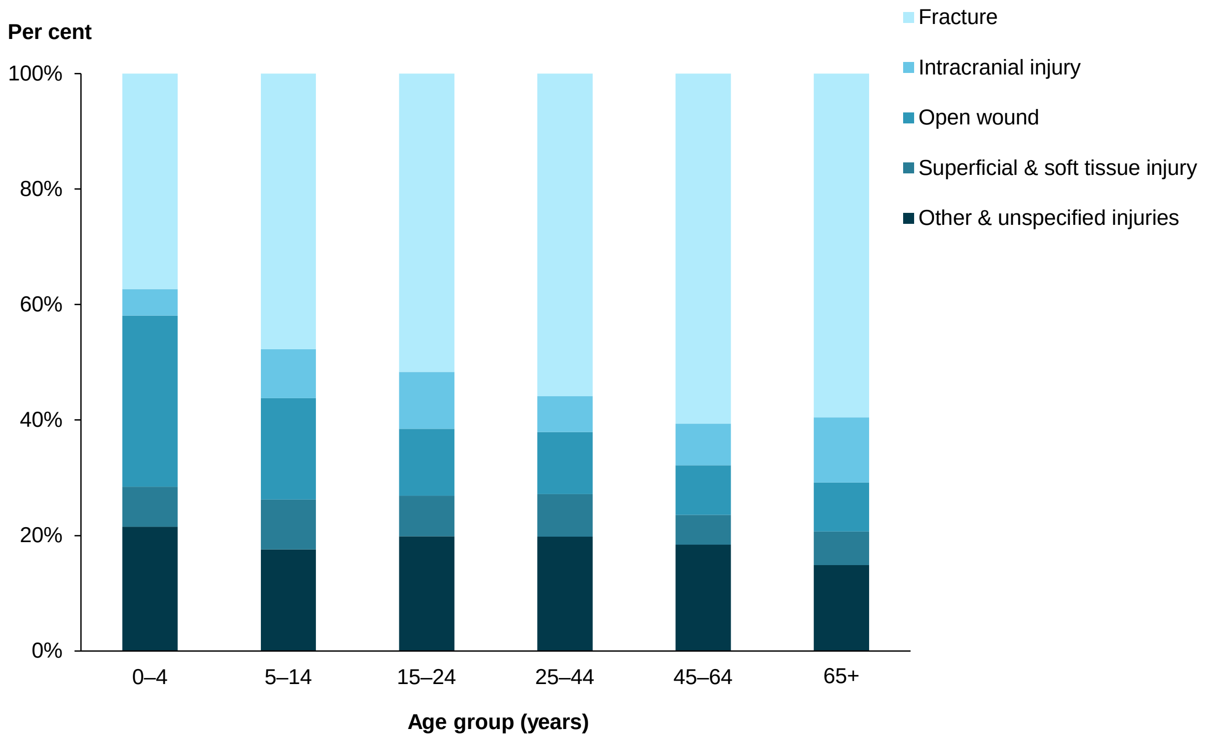
What injuries were sustained?

In Chapter 3, Figure 3.5 showed the most common types of injury for hospitalised cyclists and other types of land transport injury case. Figure 5.1 shows the nature of the principal diagnosis injuries sustained by pedal cyclists, according to age group.

The injuries summarised here are those that were recorded as the Principal Diagnosis. Fractures were the most common type of injury in all age groups. Proportionately, they were highest in the 2 oldest age groups, accounting for 6 in 10 of the injuries sustained.

About one-third of children aged 0–4 were hospitalised with open wounds, while intracranial injury was proportionately most common in those aged 5–14 (9%), 15–24 (10%), and 65 and over (11%).

Figure 5.1: Hospitalised cases of pedal cyclist injury, by age and type of injury sustained, 2015–16



Note: Data for this figure are available in Supplementary table S5.1.

Source: NHMD.

Which parts of the body were affected?

As shown in Figure 3.6, across all ages in 2015–16, the 2 most commonly injured body regions for hospitalised cyclists were the upper limb (43%), and head and neck (26%).

When looking exclusively at fractures—the most common type of injury recorded as the principal diagnosis—the upper limb was affected in 61% of cases. Figure 5.2 shows that the body regions affected by fractures varied according to age.

Notable was the high proportion of head and neck fractures in children aged 0–4 (20%). Head and neck fractures were also comparatively common in cyclists aged 15–24 (13%), 25–44 (12%), and 45–64 (13%).

Although fractures of the upper limb accounted for 38% of all fractures among people 65 and over, lower limb fractures were also common, at 27%. This is noteworthy because about two-thirds of these lower limb fractures (65%) involved the hip and thigh. Fractures of the hip and thigh often have serious consequences in older adults.

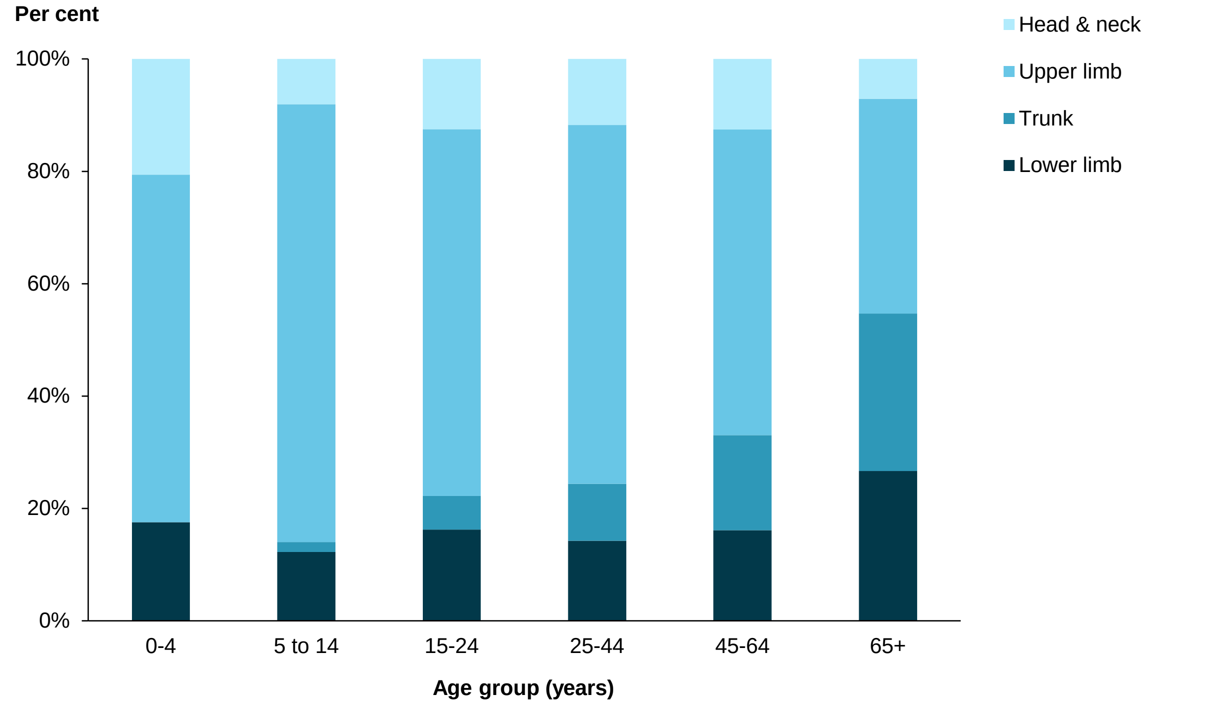
Fractures affecting the trunk were comparatively rare among children, but the proportion increased with age, and these fractures were relatively prominent in older age groups (Figure 5.2).

For those aged 25 and over, 45% of fractures to the trunk were fractured ribs. Fractures of the pelvis were also common among older cyclists, accounting for 28% of injuries to the trunk among those aged 45–64, and for 44% among those aged 65 and over.

Two types of fracture are particularly serious for older people—femur and pelvis. These were substantially more common among older cyclists than at younger ages.

For hospitalised cyclists aged 65 and over, a fractured femur was the primary injury in 10% of cases. This compares with only 1% of cases for those aged under 25. A fracture of the pelvis accounted for 7% of all of the primary diagnoses recorded for people 65 and over, compared with less than 1% for those aged under 25.

Figure 5.2: Hospitalised cases of fracture among injured pedal cyclists, by age and body region affected, 2015–16



Note: Data for this figure are available in Supplementary table S5.2.

Source: NHMD.

How serious were the injuries?

Overall, the mean length of stay of hospitalised pedal cyclists increased with age, ranging from 1.5 days for children aged 0–4 to 4.4 days for people aged 65 and over (Table 5.1).

This pattern varied according to the type of injury sustained. For example, mean length of stay for superficial injury was fairly similar between age groups, whereas for fractures, the average hospital stay for pedal cyclists in the 2 oldest age groups was 3–5 days, compared with 2 days for the younger age groups.

For intracranial injury, mean length of stay was comparatively high for the 3 oldest age groups (4–5 days), and for children aged 0–4 (4 days).

Table 5.1: Mean length of stay (days) for hospitalised cases of pedal cyclist injury, by type of injury and age, 2015–16

Type of injury	0–4	5–14	15–24	25–44	45–64	65+	All ages
Fracture	1.5	1.7	2.0	2.3	2.9	5.1	2.5
Open wound	1.3	1.4	1.6	1.6	1.9	2.1	1.6
Intracranial injury	4.0	1.9	2.0	3.8	4.2	5.1	3.3
Superficial injury	1.2	1.3	1.3	1.3	1.3	1.9	1.3
Other/unspecified injuries	1.3	1.9	2.3	2.2	2.7	3.9	2.4
Total	**1.5**	**1.6**	**1.9**	**2.2**	**2.7**	**4.4**	**2.3**

Source: NHMD.

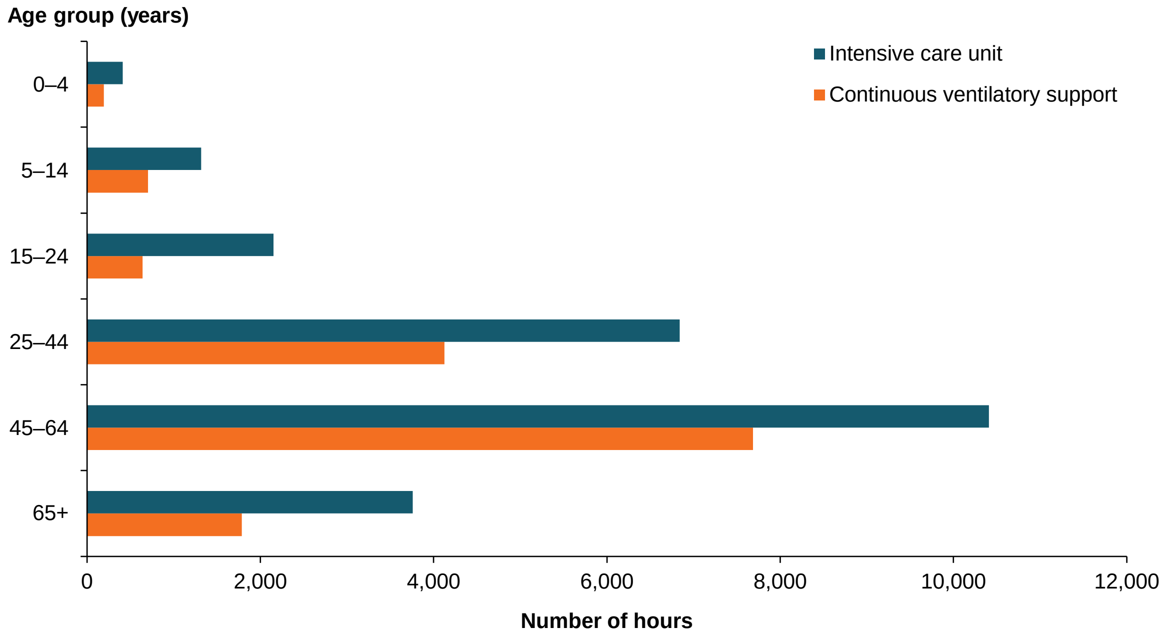
In severe cases, an injured person might require continuous ventilatory support. This refers to the use of a machine to assist a patient's breathing.

In 2015–16, hospitalised pedal cyclists required about 15,000 hours of continuous ventilatory support (Figure 5.3). About three-quarters (74%) of these hours of care were delivered to people who had sustained an intracranial injury.

Those in the oldest 3 age groups consumed 90% of the total hours of ventilatory support, with more than half being provided to cyclists aged 45–64.

Continuous ventilatory support is usually administered in an intensive care unit. Across all ages, hospitalised pedal cyclists spent nearly 25,000 hours in intensive care, equivalent to about 1,000 days. Those in the oldest 3 age groups also spent the most time in an intensive care unit (84%), with 42% of the total hours being provided to those aged 45–64.

Figure 5.3: Hospitalised cases of pedal cyclist injury, by age and hours of continuous ventilatory support and/or hours spent in intensive care, 2015–16



Note: Data for this figure are available in Supplementary table S5.3.

Source: NHMD.

Table 5.2 shows severity indicators for fractures (the most frequent type of injury) and intracranial injury (often the most severe type of injury).

The proportion of fracture cases that were assessed as being life threatening rose with age. For example, while only 5% of fractures in children aged 0–4 and 5–14 posed a high threat to life, this proportion rose to 49% in those aged 65 and over.

Another indicator of injury severity is the need to transfer a person to another acute care hospital. The highest proportion of transfers for both fractures and intracranial injury was in those aged 65 and over, with more than 1 in 5 people being transferred.

Table 5.2: Hospitalised cases of selected types of pedal cyclist injury, by indicators of severity, age and selected types of injury, 2015–16

Type of injury	Age group (years)	Cases	Mean length of stay (days)	High threat to life (%)	Transferred to another acute care facility (%)
Fracture	0–4	97	1.5	5.2	6.2
	5–14	1,126	1.7	5.4	8.3
	15–24	832	2.0	13.6	6.0
	25–44	2,054	2.3	19.4	6.4
	45–64	1,925	2.9	33.1	9.2
	65+	563	5.1	48.7	21.5
	All ages	**6,597**	**2.5**	**22.6**	**8.8**
Intracranial	0–4	12	4.0	8.3	0.0
	5–14	201	1.9	25.4	5.5
	15–24	159	2.0	30.2	8.8
	25–44	227	3.8	43.2	7.9
	45–64	228	4.2	53.1	11.4
	65+	107	5.1	73.8	22.4
	All ages	**934**	**3.3**	**42.6**	**10.0**

Source: NHMD.

6 Change in the age profile of hospitalised pedal cyclists over time

This report has shown that:

- many hospitalised pedal cyclists are aged 45 and over
- the severity of pedal cyclist injury cases tends to worsen with increasing age
- population-based rates of hospitalised pedal cyclist cases have risen over time.

This chapter focuses on age-specific trends over time, and on the changing age profile of hospitalised pedal cyclists in Australia.

The age composition of hospitalised pedal cyclist injury cases changed markedly between the first and last parts of the period 1999–00 to 2015–16 (Table 6.1).

These changes were particularly pronounced in some age groups. For example, in 1999–00, cases in the 5–14 age group comprised 48% of all pedal cyclist cases, compared with 20% in 2015–16. In contrast, in the first year, cases in the 25–44 age group rose from 18% of all cases in 1999–00 to 31% in 2015–16, while cases in the 45–64 age groups rose from 7% to 26%. While accounting for a smaller number of cases, the proportion of people aged 65 and over more than tripled between the first and last years.

Table 6.1: Hospitalised cases of pedal cyclist injury, by age, 1999–00 and 2015–16

	1999–00			2015–16		
Age group (years)	**Number**	**%**	**Adjusted rate**	**Number**	**%**	**Adjusted rate**
0–4	349	4.6	27.3	260	2.2	16.6
5–14	3,698	48.4	139.2	2,360	19.6	80.4
15–24	1,506	19.7	58.4	1,611	13.4	52.0
25–44	1,354	17.7	23.4	3,676	30.6	54.3
45–64	536	7.0	12.5	3,174	26.4	54.6
65+	192	2.5	8.2	946	7.9	25.9
All ages	**7,635**	**100.0**	**40.2**	**12,027**	**100.0**	**51.7**

Source: NHMD.

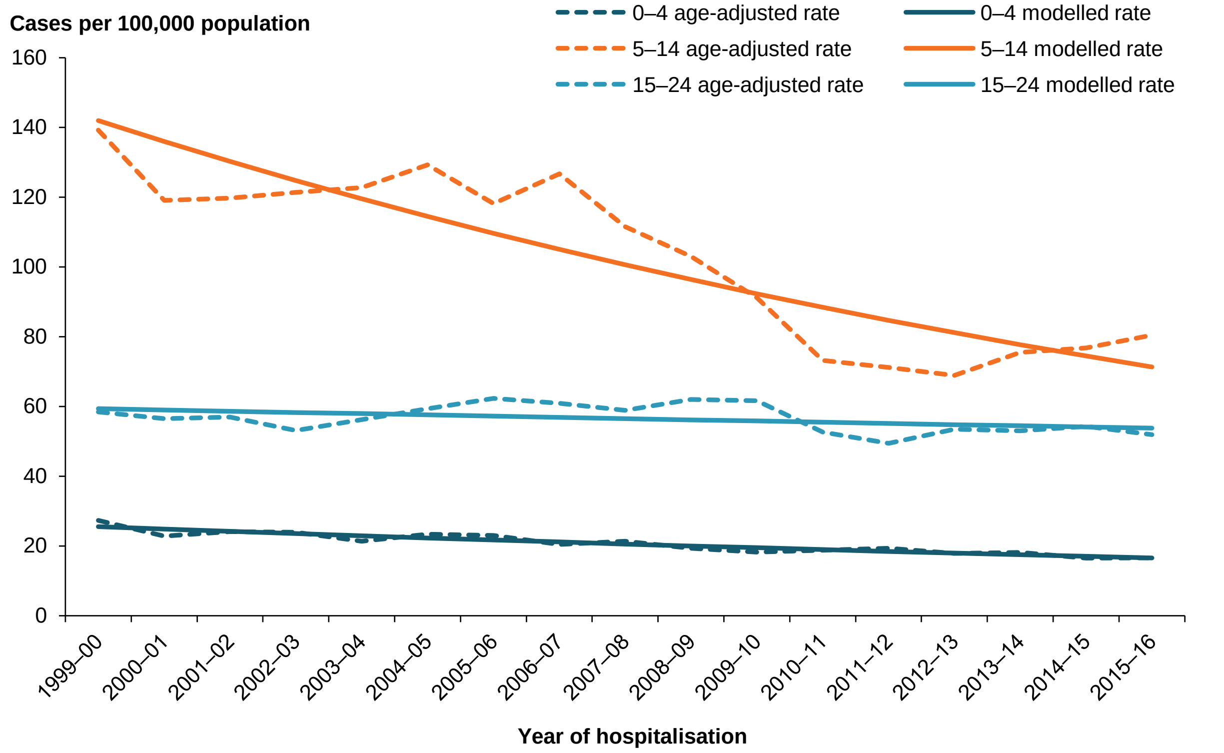
Over the 17-year period, there was a downward trend in age-adjusted rates for each of the 3 youngest age groups (Figure 6.1).

Rates fell each year by an average of:

- 2.7% children aged 0–4 (95% CI: –3.2 to –2.1)
- 4.2% for children aged 5–14 (95% CI: –5.2 to –3.2)
- 0.6% for young adults aged 15–24 (95% CI: –1.2 to 0.0).

Figure 6.1 shows large fluctuations in the year-to-year variation in age-adjusted rates for the 5–14 group, so the summary value of an annual drop in rates of 4.2% might not be an ideal reflection of trends in rates at different times over the total period. Fitting the model to separate parts of the total time span arrived at estimated trends for the 3 sub-periods shown in Table 6.2.

Figure 6.1: Age-adjusted rates and modelled rates for hospitalised pedal cyclists aged under 25, by age, 1999–00 to 2015–16



Note: Data for this figure are available in Supplementary table S6.1.

Source: NHMD.

Table 6.2: Annual change in age-adjusted rates of pedal cyclist injury hospitalisation, children aged 5–14, 1999–00 to 2006–07, 2006–07 to 2010–11 and 2010–11 to 2015–16

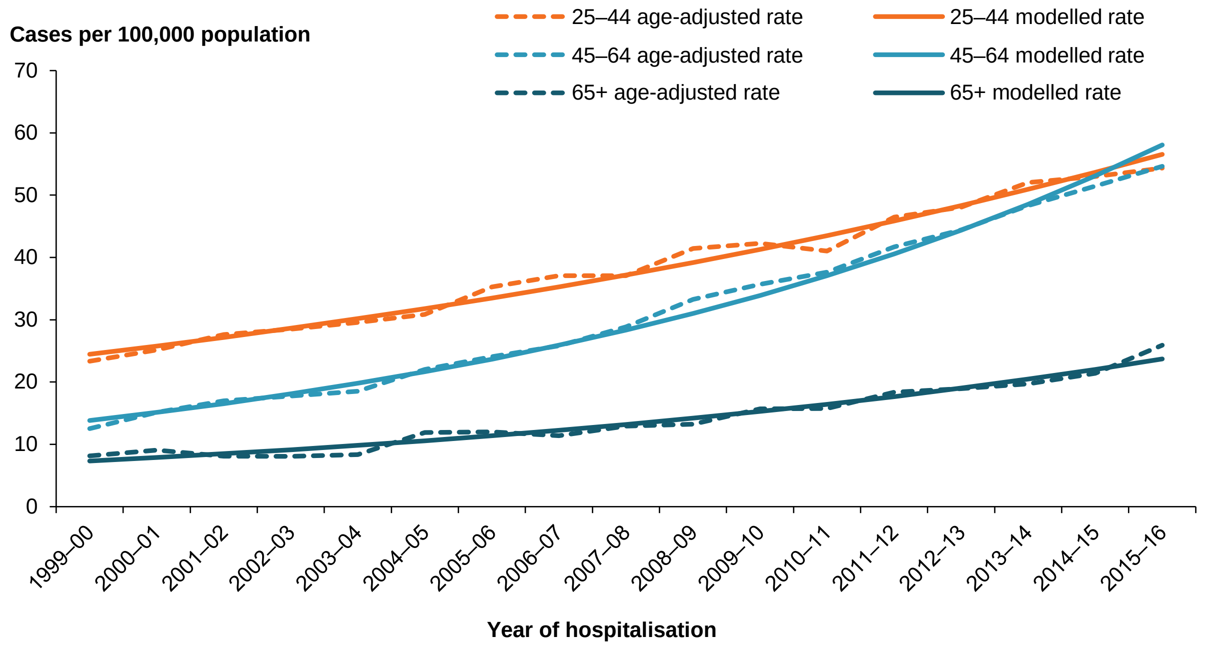
Period	Annual change (%)	95% CI
1999–00 to 2006–07	↓ 0.9	–2.1 to 0.9
2006–07 to 2010–11	↓ 12.1	–13.9 to –10.2
2010–11 to 2015–16	↑ 2.3	0.8 to 3.9

Source: NHMD.

Over the 17-year period, age-adjusted rates rose consistently in the 3 oldest age groups (Figure 6.2). Rates rose each year by an average of:

- 5.4% for people aged 25–44 (95% CI: 5.0–5.7)
- 9.4% for people aged 45–64 (95% CI: 8.9–9.8)
- 7.6% for people aged 65 and over (95% CI: 6.8–8.4).

Figure 6.2: Age-adjusted rates and modelled rates for hospitalised pedal cyclists aged 25 and over, by age, 1999–00 to 2015–16



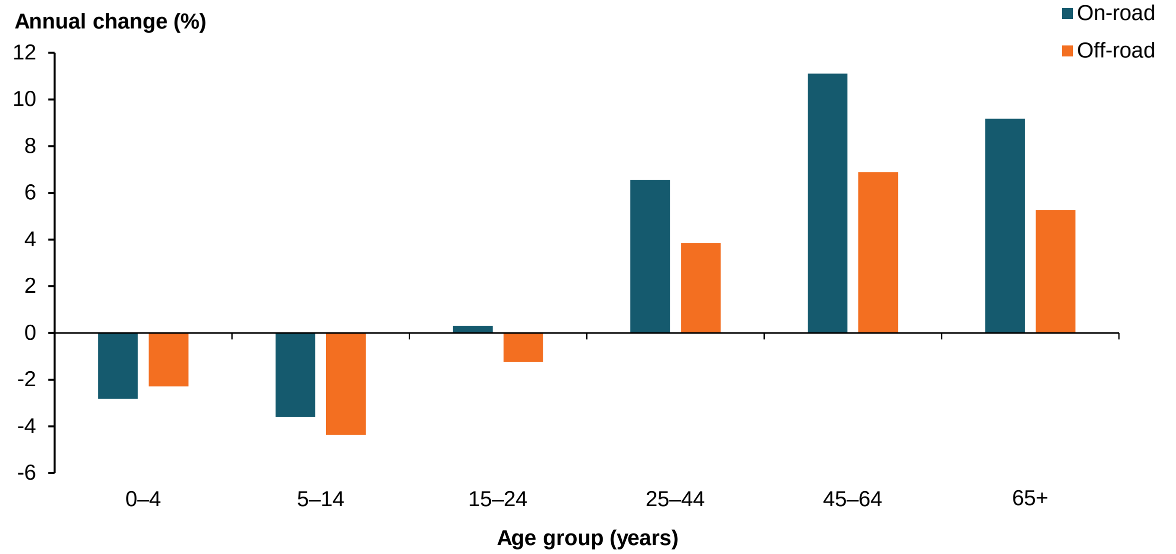
Note: Data for this figure are available in Supplementary table S6.2.

Source: NHMD.

Figure 6.3 summarises trends for the age groups shown in figures 6.1 and 6.2. There was a decline in annual average rates in the 3 youngest age groups, and a comparatively greater increase in rates in the 3 oldest age groups.

Annual average changes in rates differed according to whether the crashes occurred on-road or off-road. In the older age groups, these differences were substantial (Table 6.3). In the 3 younger age groups, the change differed little between on-road and off-road cases.

Figure 6.3: Annual change in age-adjusted rates of pedal cyclist injury hospitalisation, by age and on-road/off-road status, 1999–00 to 2015–16



Note: Data for this figure are available in Supplementary table S6.3.

Source: NHMD.

Table 6.3: Annual change in age-adjusted rates of pedal cyclist injury hospitalisation, by age and on-road/off-road status, 1999–00 to 2015–16

Age group (years)	On-road		Off-road	
	Annual change (%)	95% CI	Annual change (%)	95% CI
0–4	↓ 2.8	–4.1 to –1.5	↓ 2.3	–3.0 to –1.6
5–14	↓ 3.6	–5.0 to –2.2	↓ 4.4	–5.2 to –3.5
15–24	↑ 0.3	–0.3 to 0.9	↓ 1.2	–1.9 to –0.5
25–44	↑ 6.6	5.9 to 7.2	↑ 3.9	3.3 to 4.5
45–64	↑ 11.1	10.3 to 11.9	↑ 6.9	6.3 to 7.5
65+	↑ 9.2	8.5 to 9.9	↑ 5.3	4.0 to 6.6

Source: NHMD.

These trends underlie the marked change in the age profile of hospitalised pedal cyclists in Australia over the 17 years—mainly rises in rates of cases at older ages.

Available literature shows that various factors make older cyclists more vulnerable to injury and to poorer outcomes after injury. For example, Tochukwu et al. (2018) suggest that physiological changes associated with ageing might affect older cyclists' ability to ride a bicycle in a competent and safe manner:

- Reduced vision can lead to an increase in night-time falls, difficulty in observing traffic and signs, and poor adaptability to changing traffic conditions.
- Reduced muscle strength can affect balance, leading to increased falls due to instability, and generally impair the ability to properly operate a bicycle.
- Cognitive decline might result in poor judgment, increased chances of getting lost, and an inability understand traffic signs, signals, and warnings.

The presence of comorbid conditions increases with age, and multiple morbidities are much more prevalent among older people (Barnett et al. 2012; Britt et al. 2008). A Scottish study of nearly 2 million people, found that, by the age of 50, half had at least 1 morbidity, and by the age of 65, the majority had multiple morbidities (Barnett et al. 2012).

Comorbidity might affect trauma outcomes. For example, patients with 1 or more pre-existing conditions have a higher risk of mortality after injury (Hollis et al. 2006). Comorbidities might also affect a person's ability to return to work after injury (Gabbe et al. 2016).

Increasing age is also associated with functional outcome. A 2-year study of adult major trauma survivors found that those in older age groups showed a decline in function over time (Gabbe et al. 2016). Other studies have also shown that the likelihood of being left with persisting disability after a serious injury increases with age (Gabbe et al. 2012; Holtslag et al. 2007; Sluys et al. 2005).

As people get older, their outcomes after injury are often worse. Various physiological changes associated with increasing age bring with them greater vulnerability (Adams & Holcomb 2015). For example, as people age, loss of bone and muscle mass causes a marked increase in skeletal fracture, particularly of the hip and spine (Weaver & Peacock 2019).

A pronounced vulnerability in elderly people is often termed 'frailty' which describes a decreased physiological reserve, leading to an impaired capacity to tolerate physiological stress (Adams & Holcomb 2015). Frailty has been shown to be a major predictor of poor health outcomes. One study has found that frail trauma patients were 2.5 times as likely as other patients to develop complications while in hospital (Joseph et al. 2017).

The term ‘elderly’ is usually applied to people aged 65 and over, but this definition is largely arbitrary. For example, 1 study has found that people aged 45 and over have a higher rate of complications and mortality after trauma (Adams et al. 2012).

This report has shown that older cyclists spend longer in hospital after an injury, and they require higher levels of specialist treatment, such as ventilatory support, they spend longer in intensive care, and are more likely to be transferred to another acute care hospital. These factors lead to greater costs, both economically and socially.

According to the ABS, in 2017 people aged 65 and over made up 15% of the Australian population. By 2066, this proportion is expected to rise to 21%–23% (ABS 2018). So, it can be expected that, over coming decades, the costs associated with the hospitalisation of older cyclists will grow markedly.

Appendix A: Data issues

Data sources

Hospital separations data

The data on hospital separations are from the Australian Institute of Health and Welfare's (AIHW) National Hospital Morbidity Database (NHMD). Comprehensive information on the quality of the data for 2015–16 is available in *Australian hospital statistics 2015–16* (AIHW 2017) and in previous editions covering the 2007–08 to 2014–15 period. Nearly all injury cases admitted to hospitals in Australia are included in the NHMD data reported.

Diagnoses and external causes of injury and poisoning were recorded using the International Statistical Classification of Diseases and Related Health Problems, 10th revision, Australia modification (ICD-10-AM).

Nine editions of ICD-10-AM were used during the period covered by this report. The first 7 editions were published by the National Centre for Classification at the University of Sydney (NCCH 1998, 2000, 2002, 2004, 2006, 2008, 2010). The 8th edition, introduced in July 2013, was published by the National Casemix and Classification Centre at the University of Wollongong (NCCC 2013). The 9th edition, introduced in July 2015, was published by the Australian Consortium for Classification Development (ACCD 2015).

Denominators for age-specific and age-standardised rates were calculated using estimated resident population values as at 31 December of the relevant year. Australian estimated resident population for 30 June 2001 (persons, by 5-year age groups to an oldest group of 85 and older) were used as the standardising population throughout the report (see 'Rates' section in this appendix).

Deaths data

Data on deaths are from the AIHW National Mortality Database, which comprises cause-of-death unit record file data, provided to the AIHW by the Registries of Births, Deaths and Marriages and the National Coronial Information System, and coded by the ABS.

Data are presented according to the financial year in which each death occurred, rather than year of registration or ABS reference year. This is because:

- presenting data by year of occurrence provides a more meaningful interpretation of data than presenting data by year of registration, where cases can be registered significantly after the death occurred (in some cases, years)
- reporting by financial year is in line with the AIHW practice of publishing reports based on morbidity data.

Selection criteria

Hospital separations

This report includes hospital separations that:

- occurred in Australia between 1 July 1999 and 30 June 2016
- had a principal diagnosis in the ICD-10-AM range S00–T75 or T79, using Chapter 19 *Injury, poisoning and certain other consequences of external causes*

- had a first reported external cause code in the range V10–V19, *Pedal cyclist injured in transport accident*
- did not contain the code Z50, *Care involving use of rehabilitation procedures* in any of the diagnosis fields
- did not have a mode of admission of transfer from another acute hospital.

The codes are from the World Health Organization's International Statistical Classification of Diseases and Related Health Problems, 10th revision (WHO 2016). The external cause codes are from Chapter 20 *External causes of morbidity and mortality*, and the injury codes are from Chapter 19 *Injury, poisoning and certain other consequences of external causes*.

Important terms about the data used in this report are summarised in boxes 1.1 and 1.2, and the Glossary.

Code Z50, *Care involving the use of rehabilitation procedures*

A change in coding practice for ICD-10-AM Z50, *Care involving the use of rehabilitation procedures* has necessitated a change to the standard record inclusion criteria for reports of hospital admitted injury cases by the AIHW National Injury Surveillance Unit.

The change applies to episodes that ended on 1 July 2015, or later. For details of the change see box 4.2 in *Admitted patient care 2015–16: Australian hospital statistics* (AIHW 2017).

The change in coding practice resulted in a rise in the numbers of separations in 2015–16 with a principal diagnosis in the ICD-10-AM code range S00–T98, in Chapter 19 *Injury, poisoning and certain other consequences of external causes* (an additional 60,000 records or so).

To minimise the effect of the coding change on the estimation of injury occurrence and trends, the AIHW National Injury Surveillance Unit changed its case estimation method.

Records with Z50 either as principal diagnosis or as an additional diagnosis are now omitted, both before and after the coding change. The change to data before 2015–16 amounts to a downwards adjustment of less than 0.1% of records. Where injury trends are presented by principal diagnosis for years before 2015–16, data will not be directly comparable with earlier reports in which this restriction was not applied.

Estimating incident cases for hospitalisations

Each record in the NHMD refers to a single episode of care in a hospital. Some injuries result in more than 1 episode in hospital, so the same injury for the same person might have more than 1 NHMD record.

This can occur when:

- a person is admitted to 1 hospital, then transferred to another, or has a change in care type (for example, acute to rehabilitation) within the same hospital
- a person has an episode of care in hospital, is discharged home (or to another place of residence), and is then admitted for further treatment for the same injury to the same hospital or another.

The NHMD does not include information designed to enable the set of records belonging to an injury case to be recognised as such. So, there is potential for some incident injury cases to be counted more than once, when a single incident injury case results in 2 or more NHMD records being generated, all of which satisfy the selection criteria being used.

Information in the NHMD enables this problem to be reduced, though not eliminated. The approach used for this report makes use of the 'Mode of admission' variable, which indicates whether the current episode began with inward transfer from another acute care hospital. Episodes of this type (inward transfers) are likely to have been preceded by another episode that also met the case selection criteria for injury cases, so are omitted from our estimated case counts.

This procedure should largely correct for over-estimation of cases due to transfers, but will not correct for overestimation due to re-admissions. Omission of records that meet the project inclusion criterion but contain code Z50, *Rehabilitation*, reduces overestimation due to re-admissions.

Deaths

Deaths were determined as being due to injury and poisoning and included in this report if:

- the death occurred between 1 July 1999 and 30 June 2016, and had been registered by 31 December 2015
- the underlying cause of death was an external cause code in the range V10–V19.

The codes are from the ICD-10 (WHO 2016). The code range V01–V99 includes all unintentional (accidental) transport-related deaths, and the range V10–V19 covers deaths that resulted from a pedal cyclist being injured in a transport-related accident.

Important terms about the data used in this report are summarised in boxes 1.1, 1.2, and 1.3, and the Glossary.

Reporting categories of cases

The reporting categories 'on-road' and 'off-road', and 'land transport user type' used in this report combine categories in Chapter 20 *External causes of morbidity and mortality* of ICD-10-AM and ICD-10. The categories 'nature of injury' and 'body region' combine categories in Chapter 19 *Injury, poisoning and certain other consequences of external causes*.

Records where the first reported external cause code is in the range V10–V18 and the fourth character is 3 (V10–V18.[3]) are not included in the categories 'on-road crashes' and 'off-road crashes'. These records refer to incidents in which a pedal cyclist was injured 'while boarding or alighting'. It is not known whether such cases occurred on-road or off-road. In 2015–16, there were 233 such cases (1.9% of the 12,027 hospitalised pedal cyclist cases during that year).

On-road crashes

Cases of pedal cyclist injury were defined as being due to on-road crashes if:

- the hospitalisation record had a first reported ICD-10-AM external cause code specified as being for use in traffic cases: V10–V18.[4,5,9], V19.[4,5,6,9]
- the death record had, as the underlying cause of death, an ICD-10 external cause code specified as being for use in traffic cases: V10–V18.[4,5,9], V19.[4,5,6,9].

Off-road crashes

Cases of pedal cyclist injury were defined as being due to off-road crashes if:

- the hospitalisation record had a first reported ICD-10-AM external cause code specified as being for use in non-traffic cases: V10–V18.[0,1,2], V19.[0,1,2,3].

- the death record had, as the underlying cause of death, an ICD-10 external cause code specified as being for use in non-traffic cases: V10–V18.[0,1,2], V19.[0,1,2,3].

Key: For all those codes, V10–V18.[1] includes all cases where the first reported external cause code is in the range V10–V18 and the fourth character is 1.

The ICD-10-AM instructs coders that if it is not specified whether a case occurred in traffic, then they should assume that it did not occur in traffic if the event is classifiable to:

- categories V83–V85, which refer to special vehicles for industry, agriculture, and construction
- V86, which refers to special all-terrain vehicles not normally registrable for on-road use.

Otherwise, including pedal cyclist cases, coders are instructed to assume that injury events involving land vehicles occurred in traffic. It is not known how many pedal cyclist cases were coded as occurring in traffic due to the use of this rule.

Land transport user type

Cases of hospitalisation and death were defined as being due to a land transport accident if they contained a first reported ICD-10 or ICD-10-AM external cause code in the range V00–V89.

Hospital separation cases were categorised depending on the first reported ICD-10-AM external cause code, as:

- pedestrian for codes V00–V09
- pedal cyclist for codes V10–V19
- motorcyclist for codes V20–V29
- motor vehicle occupant for codes V30–V79
- other/unspecified land transport user for codes V80–V89.

The ICD-10 code V99, *Unspecified transport accident* was not included in the road user type categories. Although it is possible that some of the cases assigned V99 as their first reported external cause code involved land transport, this could not be confirmed. In 2015–16, a total of 157 hospital cases were assigned V99 as the first reported external cause code.

Body region

An abbreviated list of the principal body region affected by an injury was used for the analyses of hospital separations in this report. Cases were assigned to a body region category if the record had a principal diagnosis code from ICD-10-AM Chapter 19. Cases were categorised as:

- head and neck for codes S00–S19
- trunk for codes S20–S39
- upper limb for codes S40–S69
- lower limb for codes S70–S99
- other and unspecified for:
  - *Injuries involving multiple body regions:* T00–T07
  - *Injuries to unspecified part of trunk, limb, body region:* T08–T14
  - *Effects of foreign body entering through natural orifice:* T15–T19

- *Burns:* T20–T31
- *Frostbite:* T33–T35
- *Poisoning and toxic effects:* T36–T50, T51–T65
- *Other and unspecified effects of external causes:* T66–T78
- *Early complications of trauma:* T79
- *Complications of surgical and medical care, not elsewhere classified:* T80–T88
- *Other complications of trauma, not elsewhere classified:* T89
- *Sequelae:* T90–T98.

Nature of injury

An abbreviated list of the nature of injury sustained was used for the analyses of hospital separations in this report. Cases were assigned to an injury category if the record had a principal diagnosis code from ICD-10-AM Chapter 19. Cases were categorised as:

- fracture for codes S0n–S9n[2], T02, T08, T10, T12, T14.2
- open wound for codes S0n–S9n[1], T01, T09.1, T11.1, T13.1, T14.1
- intracranial injury for code S06
- superficial and soft tissue injury:
  - *Superficial injury:* S0n–S9n[0], T0.0, T09.0, T11.0, T13.0, T14.0
  - *Soft-tissue injury:* S03n[4,5], S13n[4,5,6], S23n[0,3,4,5], S33n[0,4,5,6,7], S43n[4,5,6,7], S53n[2,3,4], S63n[3,4,5,6,7], S73.1, S83n[2,3,4,5,6,7], S93n[2,4,5,6], S16, S4n–S9n[6], T03, T09.2, T11.2, T13.2, T14.3, S09.1, S29.0, S39.0, T06.4 T09.5, T11.5, T13.5, T14.6.
- other injuries:
  - *Dislocations:* S03n[0,1,2,3], S13n[1,2,3], S23n[1,2], S33n[1,2,3], S43n[0,1,2,3], S53n[0,1], S63[0,1,2], S73.0, S83n[0,1], S93n[0,1,3]
  - *Injury to internal organs:* S26–S27, S36–S37, S25, S35, S39.6, T06.5
  - *Injury of blood vessels:* S09.0, S15, S4n–S9n[5], T06.5
  - *Burns:* T20–T31
  - *Poisoning and toxic effects:* T36–T65
  - *Eye injury:* S05
  - *Nerve injury:* S0n–S9n[4], T06.0, T06.1, T06.2, T06.3, T09.3, T09.4, T11.3, T13.3, T14.4
  - *Crushing injury:* S07, S17, S4n–S9n[7], T04, S28.0, S38.0, S38.1
  - *Amputation:* S08, S18, S4n–S9n[8], T05, S28.1, S38.2, S38.3, T09.6, T11.4, T11.6, T13.4, T13.6, T14.5
  - *Foreign body in natural orifice:* T15–T19
  - Frostbite: T33–T35
  - *Other specified injuries:* S09.2, T14.7, S0nn–S9nn[97], S0nn–S9nn[98], T06.8, T098, T11.8, T13.8, T14.8
  - *Early complications of trauma:* T79
  - *Sequelae:* T90–T98
  - *Complications of surgical and medical care, not elsewhere classified:* T80–T88
  - *Adverse effects, not elsewhere classified:* T78

- *Other/unspecified effects of external causes:* T66–T75.

- unspecified injuries for codes S0nn–S9nn[99], T07, T09.9, T11.9, T13.9, T14.9.

Key: In the lists of codes shown above, S0n–S9n[2] includes all cases where the first 2 characters of the principal diagnosis code for the record are in the range S0–S9, and the 3rd character is ‘2’.

S0nn–S9nn[99] includes all cases where the first 2 characters of the principal diagnosis code are in the range S0–S9, and the 3rd and 4th characters are ‘9’.

S33n[1,2,3] includes cases where the first 3 characters of the code are ‘S33’ and the 4th character is either ‘1’, ‘2’ or ‘3’.

Rates

Age-standardisation

Population-based rates were generally age-standardised to allow for comparison without distortion due to population age group differences. This was particularly important because of the use of wide-age bands such as the 65+ group. Direct standardisation was used to age-standardise rates, using the Australian population in 2001 as the standard and using 5-year age groups except for an oldest group of 85 and older.

Population denominators

All rates in this report were calculated using the final estimate of the resident population as at 31 December in the relevant year as the denominator.

Estimated change in rates over time

Estimated trends in rates of separations were reported as average annual percentage change over the 17-year study period, obtained using negative binomial regression modelling, using Stata 14.1 (StataCorp 2015).

Unless otherwise stated, a reported rise or fall in rates indicates an outcome that was statistically significant—statistical significance is defined in terms of confidence intervals (CI).

Population-based rates of injury tend to have similar values from 1 year to the next. Exceptions to this can occur (for example, due to a mass-casualty disaster), but are unusual in Australian injury data. Some year-to-year variation and other short-run fluctuations are to be expected, due to unknown and essentially random factors, so small changes in rates over a short period might not mean a trend is present.

But the period covered by this report (17 years) is long enough for noteworthy changes to occur. Important questions to ask with a series of annual estimates of population-based rates are whether they show statistically significant rises or falls over the period, and, if so, the average rate of change. Analysis in this report is limited to answering these 2 questions.

For each type of injury for which estimates of change were made:

- age-adjusted annual case numbers were obtained by multiplying age-adjusted unscaled rates by the Australian population in the corresponding year
- negative binomial regression, a method suitable for count-based data, was run with the:
  - adjusted case numbers as the dependent variable

- year (as an integer, from 0 to the number of years of data) as an independent variable
- annual population as the exposure.

The relevant outputs are a modelled rate for each year, and a model-based estimate of average annual change in rate, and its 95% CI.

If the 95% CI around the point estimate for trend is entirely higher than 0, then the rates have risen. If the 95% CI is entirely lower than 0 then the rates have fallen. Otherwise it cannot be said with useful confidence that the age-standardised rates rose or fell in the period considered.

High threat to life

Serious injury cases posing a high threat to life are a subset of the serious injury cases. These cases are also referred to as 'life-threatening' injuries.

They are selected on the basis of having an ICD-based Injury Severity Score (ICISS) of less than 0.941. ICISS is a measure of injury severity based on a patient's injury diagnoses. The ICISS measure for this report is based on ICD-10-AM coding, and was derived using Australian hospital separations data (Stephenson et al. 2004).

ICISS involves calculating a survival risk ratio—that is, the proportion of all cases with each individual injury diagnosis code as a proportion of the total number of patients with that diagnosis code.

As such, a survival risk ratio approximates the likelihood that a person admitted to a hospital with a particular injury will survive to leave the hospital alive. Each patient's ICISS score (survival probability) is the product of the probabilities of surviving each of their survival risk ratio individually.

So, for a patient with a single injury, their ICISS is equal to the survival risk ratio for that injury, while for a patient with multiple injuries, their ICISS is equal to the product of the survival risk ratios for all of those injuries. A patient's ICISS can vary from 0 (most life-threatening) to 1 (least life-threatening).

Five-year (2002–03 to 2006–07) and 9-year (2000–01 to 2008–09) trends in age-standardised rates from for those seriously injured with high threat to life in a road vehicle traffic crash have previously been reported (AIHW: Henley & Harrison 2009, 2012). This report uses the same set of survival risk ratios and method to calculate ICISS as used in those earlier reports.

There is potential for variation over time in admission practice, especially for lower severity cases (Harrison & Steenkamp 2002), as well as jurisdictional differences in admission practice. Injuries with a high threat to life have been found to be less susceptible to changes over time in admission practice (Cryer & Langley 2006; Langley et al. 2003b), and might allow more accurate comparisons between jurisdictions.

Data quality statement: National Hospital Morbidity Database 2015–16, database quality statement summary

National Hospital Morbidity Database

A data quality statement for the NHMD is available online at meteor.aihw.gov.au.

The National Hospital Morbidity Database (NHMD) is a compilation of episode-level records from admitted patient morbidity data collection systems in Australian hospitals. The data supplied are based on the National minimum data set (NMDS) for Admitted patient care and include demographic, administrative and length of stay data, as well as data on the diagnoses of the cases, the procedures they underwent in hospital and external causes of injury and poisoning.

The purpose of the NMDS for Admitted patient care is to collect information about care provided to admitted cases in Australian hospitals. The scope of the NMDS is episodes of care for admitted cases in all public and private acute and psychiatric hospitals, free-standing day hospital facilities, and alcohol and drug treatment centres in Australia. Hospitals operated by the Australian Defence Force, corrections authorities and in Australia's off-shore territories are not in scope but some are included.

Appendix B: Participation data

Data on the level of cycling participation in Australia were obtained from the following sources:

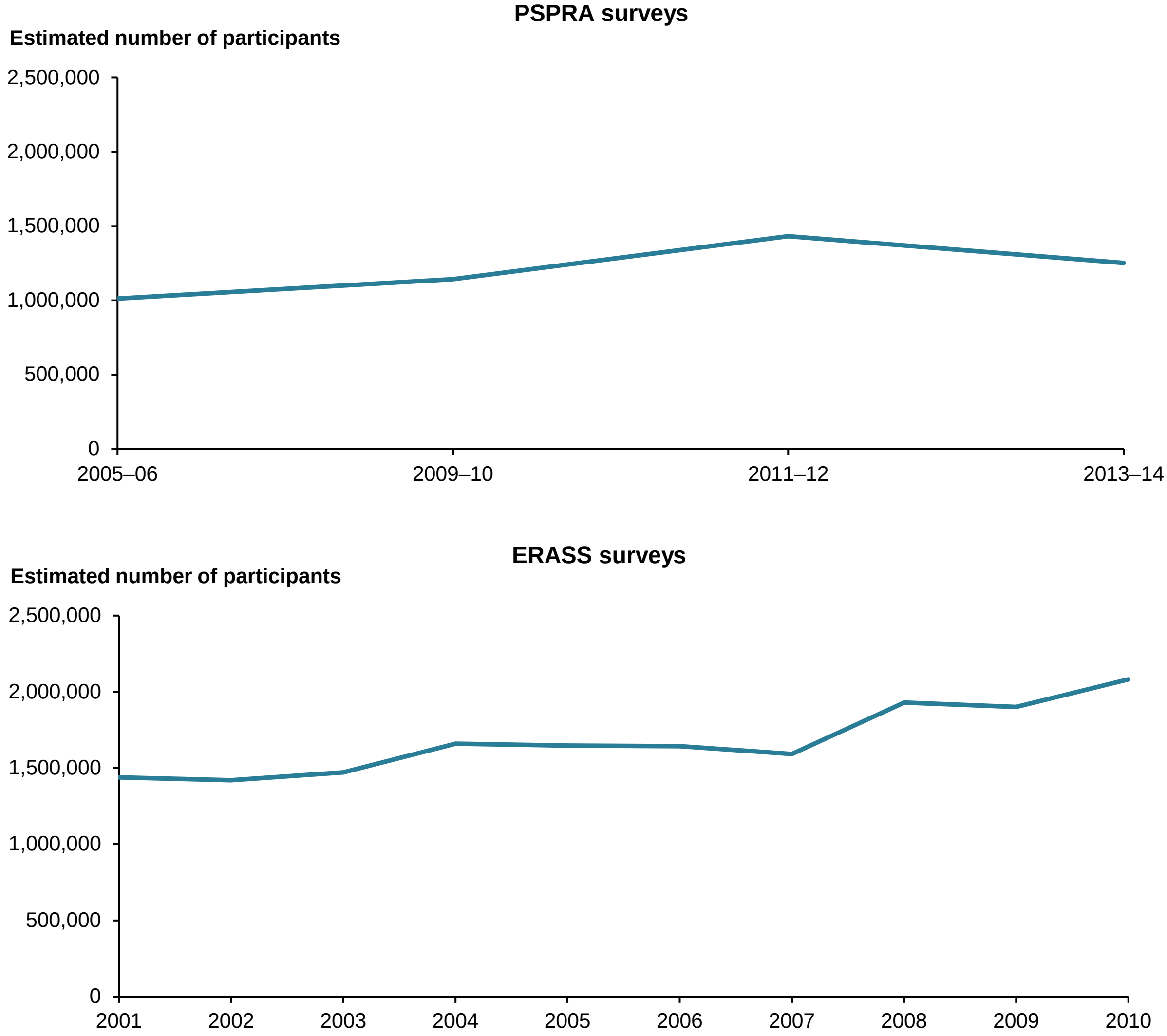
- The ABS Participation in Sport and Physical Activities (PSPRA) surveys. Although these surveys were done over an extended period, due to changes in method used, the data from only 4 were comparable (2005–06, 2009–10, 2011–12, and 2013–14). The respondents were people aged 15 and over who reported having cycled during the previous year (ABS 2007, 2010, 2012b, 2015).
- The Participation in Exercise, Recreation and Sport surveys (ERASS). These surveys were done annually between 2001 and 2010 by the Australian Sports Commission, in conjunction with state and territory departments of sport and recreation. Respondents were people aged 15 and over who had cycled during the previous year (ASC 2001–2010).
- The National Cycling Participation Survey was done by Austroads for 4 years (2011, 2013, 2015, and 2017). It collected information on both children and adults about their cycling participation during the previous week, month, and year. Information from the survey was of limited usefulness for this report, because, in general, numeric estimates of participation were not included in the published reports. The information published was largely limited to text and charts (Austroads Ltd 2017).

Trends in adults

Data from the 4 comparable PSPRA surveys, covering 2005–06 to 2013–14 show an overall rise in the estimated number of cyclists aged 15 and over up to 2011–12, followed by a fall in the most recent year of the survey. Between the first and last surveys in the series, there was a 24% rise in participants.

Over the period covered by the 10 annual ERASS surveys, the estimated number of cyclists aged 15 and over rose, particularly during the period 2008–2010. Between the first and last years of the survey, participation rose by 45% (Figure B1).

Figure B1: Estimated number of pedal cyclists, 15 and over, PSPRA surveys 2005–06 and ERASS surveys 2001–2010



Notes:

(a) Data for this figure are available in Supplementary table STB1.1.

(b) Respondents who had ridden a bicycle at least once in the previous 12 months.

When the data from the PSPRA and ERASS surveys are viewed by age group, participation rose greatly among older adults, while it either fell or rose only slightly in the younger age groups.

Between the first and last years of the comparable PSPRA surveys, participation:

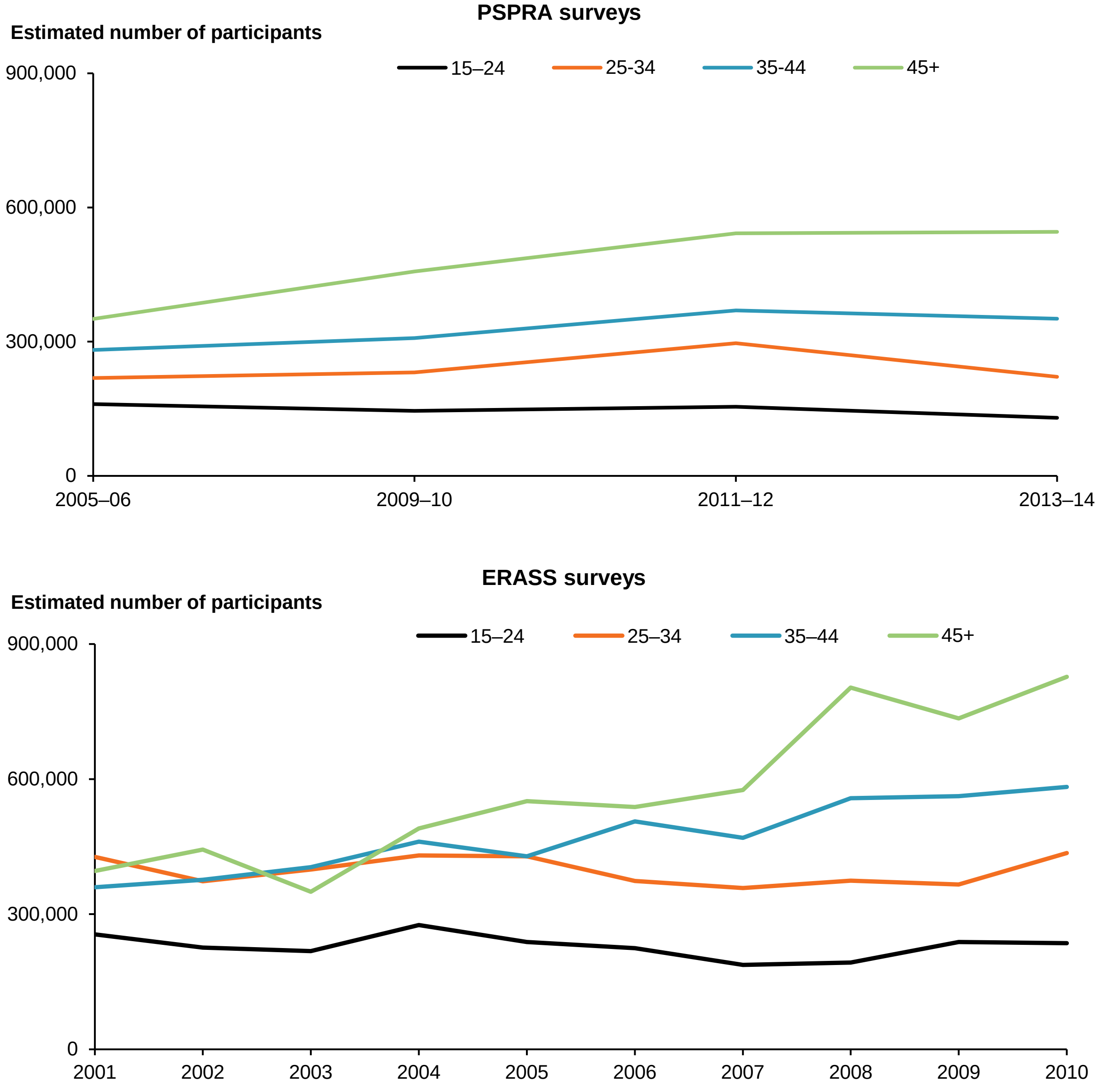
- fell by 21% among those aged 15–24
- rose by 1% among those aged 25–34
- rose by 25% among those aged 35–44
- rose by 56% among those aged 45 and over (Figure B2).

Between the first and last years of the ERASS surveys, participation:

- fell by 8% among those aged 15–24
- rose by 2% among those aged 25–34
- rose by 62% among those aged 35–44

- rose by 109% among those aged 45 and over (Figure B2).

Figure B2: Estimated number of pedal cyclists, 15 and over, by age group, PSPRA surveys 2005–06 and ERASS surveys 2001–2010



Note:

(a) Data for this figure are available in Supplementary table STB1.2.

(b) Respondents who had ridden a bicycle at least once in the previous 12 months.

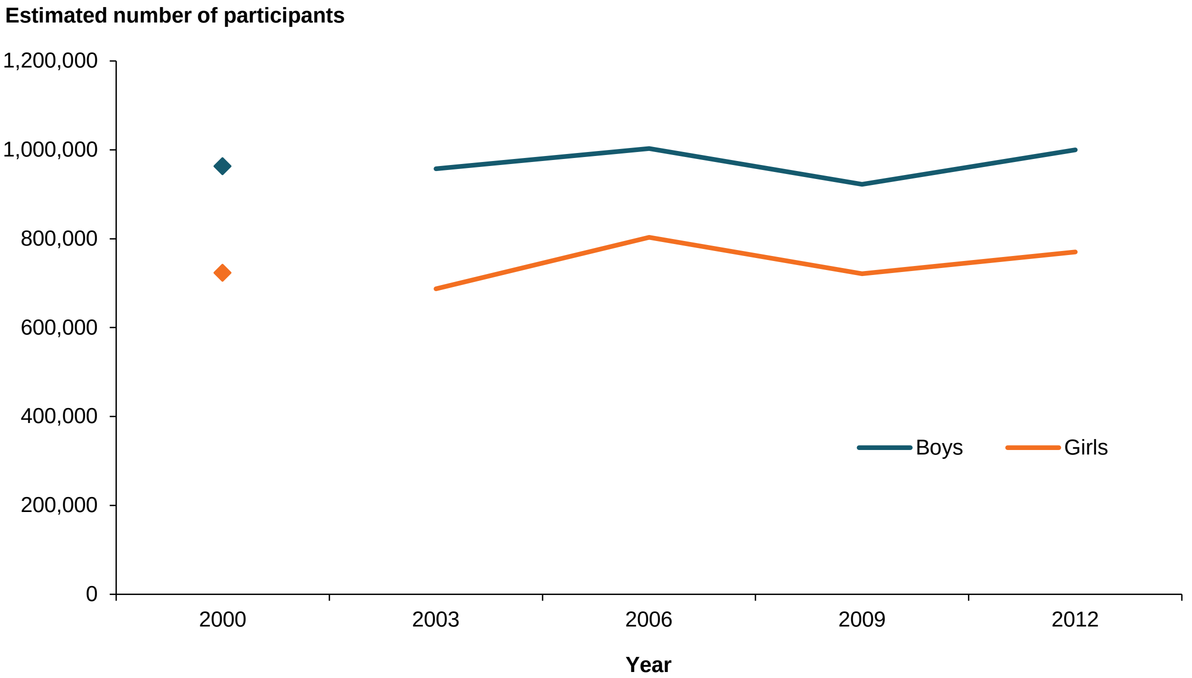
The National Cycling Participation Survey (Austroads Ltd 2017) reported that male cycling participation fell from 47% in 2011 to 40% in 2017, and female cycling from 45% to 29%.

The survey data suggest a modest decline in rates for children under 10, and found declining rates among those aged 30–49 and 50 and over, which is at odds with trends based on data from the PSPRA and ERASS surveys.

Trends in children

The ABS has published information about bicycle use by children aged 5–14 (ABS 2000, 2012a). These data suggest that, despite some fluctuation, participation remained fairly stable over time (Figure B3). Data were collected by asking children whether they had ridden a bicycle in the 2 weeks before the survey.

Figure B3: Estimated number of child cyclists, aged 5–14, by sex, 2000–2012



Notes:

(a) Data for this figure are available in Supplementary table STB1.3.

(b) Respondents who had ridden a bicycle at least twice prior to the survey.

Source for 2000 data is the ABS Survey of Children's Participation in Cultural and Leisure Activities, April 2000 (diamonds).

Source for 2003, 2006, 2009 and 2012 data is the ABS survey of Children's Participation in Sport and Leisure Time Activities, 2003–2012 (lines).

Appendix C: Other cases that mention cycling

The main part of this report focuses on cases of hospitalisation where the first reported external cause code falls in the ICD-10-AM range V10–V19, *Pedal cyclist injured in transport accident*.

During data preparation it was noticed that the NHMD includes some records that do not have an external cause code for pedal cyclist injury in land transport accidents, but do have an activity code related to cycling. Specifically, the codes U66.0, *Cycling* and U67.40, *Cycling event* (as part of a triathlon) identify cases of cycling-related hospitalisation. For completeness, a summary of those cases is provided in this appendix.

Activity codes were first assigned to hospital separations data in 2002–03. A subset of records was created for 2002–03 to 2015–16, for records that had a first reported external cause code outside the range V10–V19, but had an activity code of either U66.0, *Cycling*, or U67.40, *Cycling event.* A total of 4,827 hospital separations met these criteria.

This subset of 4,827 records was further restricted, by retaining only those that met this report's usual selection criteria for cases, namely those that:

- met the definition for community injury by having a principal diagnosis code in the range S00–T75 or T79
- did not contain the code Z50, *Care involving use of rehabilitation procedures* in any of the diagnosis fields
- had a mode of admission that was not a transfer from another acute hospital.

The restricted subset comprised 3,848 cases.

This subset of 3,848 cases (Subset 1) was compared with cases in the subset of all hospitalised cyclists that formed the basis of the analyses described in the body of this report (Subset 2)—that is, cases of hospitalisation where the first reported external cause code fell in the range V10–V19, *Pedal cyclist injured in transport accident.*

The comparison included all those who separated from hospital during 2002–03 to 2015–16 in both subsets. These subsets were compared with respect to sex, age, place of occurrence, and the nature of the major injury sustained.

Distribution of total cases for 2002–03 to 2015–16, by sex and age, was broadly similar for both subsets (tables C1 and C2).

Table C1: Distribution of cases for subsets 1 and 2, by sex, 2002–03 to 2015–16

	Subset 1		Subset 2	
	Activity code U660 or U6740, and first reported external cause code outside range V10–V19		First reported external cause code in range V10–V19	
Sex	**Number**	**%**	**Number**	**%**
Males	3,150	81.9	107,207	80.1
Females	698	18.1	26,570	19.9
Persons	**3,848**	**100.0**	**133,778**	**100.0**

Source: NHMD.

Table C2: Distribution of cases for subsets 1 and 2, by age, 2002–03 to 2015–16

	Subset 1		Subset 2	
	Activity code U660 or U6740, and first reported external cause code outside range V10–V19		First reported external cause code in range V10–V19	
Age group (years)	**Number**	**%**	**Number**	**%**
0–4	125	3.3	4,835	3.1
5–14	1,041	27.1	47,994	30.7
15–24	814	21.2	27,531	17.6
25–44	1,082	28.1	40,586	26.0
45–64	617	16.0	28,190	18.0
65+	169	4.4	7,182	4.6
All ages	**3,848**	**100.0**	**156,318**	**100.0**

Source: NHMD.

There were some notable differences between subsets 1 and 2 in the place of occurrence of the injury. In particular:

- 2.5 times as many cases in Subset 2 occurred on a street and highway as in Subset 1
- 2.5 times as many cases in Subset 1 occurred in a sports and athletics area as in Subset 2 (Table C3).

Table C3: Distribution of cases for subsets 1 and 2, by place of occurrence, 2002–03 to 2015–16

	Subset 1		Subset 2	
	Activity code U660 or U6740, and first reported external cause code outside range V10–V19		First reported external cause code in range V10–V19	
Place of occurrence	**Number**	**%**	**Number**	**%**
Home	204	5.3	4,661	3.0
Residential institution	3	0.1	52	0.0
School, other institution, and public administration area	31	0.8	674	0.4
Sports and athletics area	501	13.0	8,276	5.3
Street and highway	639	16.6	64,357	41.2
Trade and service area	8	0.2	279	0.2
Industrial and construction area	5	0.1	64	0.0
Farm	26	0.7	182	0.1
Other specified place of occurrence	494	12.8	9,927	6.4
Unspecified place of occurrence	1,928	50.1	61,005	39.0
Place not reported/not applicable	9	0.2	6,842	4.4
Total	**3,848**	**100.0**	**156,319**	**100.0**

Source: NHMD.

There were some noteworthy differences between subsets 1 and 2 in the nature of injury sustained (Table C4). In particular:

- Subset 2 (55%) had a higher proportion of fractures than Subset 1 (38%)
- Subset 2 (8%) had a slightly higher proportion of intracranial injuries than Subset 1 (5%)
- Subset 1 (20%) had a higher proportion of open wounds than Subset 2 (14%)
- Subset 1 (16%) had a higher proportion of superficial and soft tissue injuries (9%).

Table C4: Distribution of cases for subsets 1 and 2, by type of primary injury sustained, 2002–03 to 2015–16

	Subset 1		Subset 2	
	Activity code U660 or U6740, and first reported external cause code outside range V10–V19		First reported external cause code in range V10–V19	
Nature of injury	**Number**	**%**	**Number**	**%**
Fracture	1,474	38.3	86,191	55.1
Open wound	771	20.0	21,552	13.8
Intracranial injury	182	4.7	12,700	8.1
Superficial and soft tissue injury	613	15.9	14,045	9.0
Other and unspecified injury	808	21.0	21,831	14.0
Total	**3,848**	**100.0**	**156,319**	**100.0**

Source: NHMD.

The range of first reported external causes for the 3,848 cases in Subset 1 was diverse. By definition, none of the cases in Subset 1 had a first reported external cause code that fell in the range V10–V19, *Pedal cyclist injured in transport accident*, as these cases were all captured in Subset 2.

In 1.5% of cases in Subset 1, the record did not have an external cause code assigned.

In nearly one-quarter of cases (884 or 23%), the first reported external cause code fell in the range W00–W19, *Falls*.

Another 13% of cases (489) in Subset 1 had a first reported external cause code in the range indicating a transport injury event. For these cases, the external cause codes most often fell in the range V20–V29, *Motorcycle rider injured in transport accident* (336 or 69%). A total of 62 of the transport-related cases were coded to the range V00–V09, *Pedestrian injured in transport accident*.

The first reported external cause codes for some of the other cases in Subset 1 fell into definable groups. The most notable of these were cases in which a person was injured as a result of being struck by, or striking against, an object or person (553 or 14%) (Table C5).

Table C5: First reported external cause for all cases in Subset 1, 2002–03 to 2015–16

Category	Code range	Number	Percentage of all Subset 1 cases
No external cause code		58	1.5
Falls	W00–W19	884	23.0
Other fall from one level to another (W17)		*348*	
Other fall on same level (W18)		*180*	
Unspecified fall		*181*	
Transport (excluding pedal cyclist cases)	V00–V09, V20–V99	489	12.7
Pedestrian injured in transport accident (V00–V09)		*62*	
Motorcyclist injured in transport accident (V20–V29)		*336*	
Struck by, or against, an object or person	W20–W22, W50–W51	553	14.4
Struck by thrown, projected or falling object (W20)		*44*	
Struck against or by sports equipment (W21)		*136*	
Struck against or by other objects (W22)		*356*	
Overexertion	X50	226	5.9
Contact with insect, animal, or plant		258	6.7
Caught or crushed between objects		195	5.1
Exposure to natural heat, cold, or sunlight	X30–X32	52	1.4
Assault	X85–Y09	81	2.1
Other specified external causes		541	14.1
Exposure to unspecified factors	X59	511	13.3
Total		**3,848**	**100.0**

Source: NHMD.

Acknowledgments

The AIHW acknowledges the financial and project support for this publication provided by the Department of Health.

Members of the AIHW National Injury Surveillance Unit Advisory Committee provided valuable comments.

Renate Kreisfeld and James Harrison at the AIHW National Injury Surveillance Unit, Flinders University, produced this report with assistance from Sophie Pointer and Stacey Avefua.

The team acknowledges the officers of state and territory death registries and the Australian Bureau of Statistics officers who assign cause-of-death codes. The team would also like to thank AIHW staff from the Hospitals and Expenditure Group for peer reviewing the manuscript.

Abbreviations

ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
CI	Confidence interval
CODURF	cause of death unit record file
ERASS	Participation in Exercise, Recreation and Sport Survey
ICD-10	International Classification of Diseases, 10th revision
ICD-10-AM	International Classification of Diseases, 10th revision, Australian modification
ICISS	Injury Severity Score
METeOR	Metadata Online Registry
MCoD	Multiple cause of death
NCIS	National Coronial Information System
NHMD	National Hospital Morbidity Database
NMD	AIHW National Mortality Database
PSPRA	Participation in Sport and Physical Recreation, Australia
UCoD	Underlying cause of death

Glossary

The Metadata Online Registry (METeOR) is Australia's central repository for health, community services, and housing assistance metadata, or 'data about data'. It provides definitions for data for health and community services-related topics and specifications for related national minimum data sets. METeOR can be viewed at https://meteor.aihw.gov.au.

acute: Having a short and relatively severe course.

acute care: See **care type**.

acute care hospital: See **establishment type**.

admitted patient: A patient who undergoes a hospital's admission process to receive treatment and/or care. This treatment and/or care is provided over a period of time, and can occur in hospital and/or in the person's home (for hospital-in-the-home patients). METeOR identifier: 268957.

age-standardisation: A set of techniques used to remove, as far as possible, the effects of differences in age when comparing 2 or more populations.

care type: The care type defines the overall nature of a clinical service provided to an admitted patient during an episode of care (admitted care), or the type of service provided by the hospital for boarders or posthumous organ procurement (care other than admitted care).

Admitted patient care consists of:

- acute care
- rehabilitation care
- palliative care
- geriatric evaluation and management
- psychogeriatric care
- maintenance care
- newborn care
- other admitted patient care—where the principal clinical intent does not meet the criteria for any of the other categories.

Care other than admitted care include:

- posthumous organ procurement
- hospital boarder. METeOR identifier: 491557.

disability: In burden-of-disease analysis, any departure from an ideal health state.

disease: A broad term that can be applied to any health problem, including symptoms, diseases, injuries, and certain risk factors, such as high blood cholesterol and obesity. Often used synonymously with condition, disorder, or problem.

episode of care: The period of admitted patient care between a formal or statistical admission and a formal or statistical separation, characterised by only 1 care type (see **Care type** and **Separation**). METeOR identifiers: 491557 (Care type); 268956 (Episode of admitted patient care).

external cause: The environmental event, circumstance or condition as the cause of injury, poisoning and other adverse effect. METeOR identifier: 514295.

hospital: A health-care facility established under Commonwealth, state or territory legislation as a hospital or a free-standing day procedure unit, and authorised to provide treatment and/or care to patients. METeOR identifier: 268971.

International Classification of Diseases and Related Health Conditions (ICD): The World Health Organization's internationally accepted classification of diseases and related health conditions. The 10th revision, Australian modification (ICD-10-AM) is currently in use in Australian hospitals for admitted patients.

length of stay: The length of stay of an overnight patient is calculated by subtracting the date the patient is admitted from the date of separation, and deducting days the patient was on leave. A same-day patient is allocated a length of stay of 1 day.
METeOR identifier: 269982.

mode of admission: The mechanism by which a person begins an episode of admitted patient care. METeOR identifier: 269976.

mode of separation: The status at separation of the person (discharge, transfer, or death), and place to which the person is released (where applicable). METeOR identifier: 270094.

patient days: The total number of days for patients who were admitted for an episode of care, and who separated during a specified reference period. A patient who is admitted and separated on the same day is allocated 1 patient day. METeOR identifier: 270045.

principal diagnosis: The diagnosis established after study to be chiefly responsible for occasioning an episode of admitted patient care. METeOR identifier: 514273.

private hospital: A privately owned and operated institution, catering for patients who are treated by a doctor of their own choice. Patients are charged fees for accommodation and other services provided by the hospital and relevant medical and paramedical practitioners. Acute care and psychiatric hospitals private free-standing day hospital facilities are included.

public hospital: A hospital controlled by a state or territory health authority. Public hospitals offer free diagnostic services, treatment, care, and accommodation to all eligible patients.

separation: An episode of care for an admitted patient, which can be a total hospital stay (from admission to discharge, transfer, or death) or a portion of a stay beginning or ending in a change of type of care (for example, from acute to rehabilitation). Separation also means the process by which an admitted patient completes an episode of care either by being discharged, dying, transferring to another hospital, or changing type of care.

separation rate: The total number of episodes of care for admitted patients divided by the total number of people in the population under study. Often presented as a rate per 10,000 or 100,000 members of a population. Rates may be crude or standardised.

Statistical modelling: A simplified, mathematically-formalised way to estimate reality (that is, what generates observed data) so that predictions can be made from this estimate. The statistical model is the mathematical equation that is used for the modelling process.

References

ABS (Australian Bureau of Statistics) 2000. Children's participation in cultural and leisure activities, Australia, 2000. ABS cat. no. 4901.0. Canberra: ABS.

ABS 2007. Participation in sport and physical recreation, Australia, 2005–06. ABS cat. no. 4177.0. Canberra: ABS.

ABS 2010. Participation in sport and physical recreation, Australia, 2009–10. ABS cat. no. 4177.0. Canberra: ABS.

ABS 2012a. Children's participation in sport and leisure time activities, 2003–12. ABS cat. no. 4901.0.55.001. Canberra: ABS.

ABS 2012b. Participation in sport and physical recreation, Australia, 2011–12. ABS cat. no. 4177.0. Canberra: ABS.

ABS 2015. Participation in sport and physical recreation, Australia, 2013–14. ABS cat. no. 4177.0. Canberra: ABS.

ABS 2018. Population projections, Australia, 2017–2066. ABS cat. no. 3222.0. Canberra: ABS.

ACCD (Australian Consortium for Classification Development) 2015. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 9th edn. Sydney: NCCD.

Adams SD, Cotton BA, McGuire MF, Dipasupil E, Podbielski JM, Zaharia A et al. 2012. The unique pattern of complications in elderly trauma patients at a level 1 trauma center. Journal of Trauma and Acute Care Surgery 72(1):112–8.

Adams SD & Holcomb JB 2015. Geriatric trauma. Current Opinion in Critical Care 21(6):520–6.

AIHW: Henley G & Harrison JE 2015. Trends in serious injury due to road vehicle traffic crashes, Australia 2001 to 2010. Injury research and statistics series no. 89. Cat. no. INJCAT 165. Canberra: AIHW.

AIHW 2017. Admitted patient care 2015–16: Australian hospital statistics. Health services series no. 75. Cat. no. HSE 185. Canberra: AIHW.

AIHW: Henley G & Harrison JE 2009. Serious injury due to land transport accidents, Australia, 2006–07. Injury research and statistics series no. 53. Cat. no. INJCAT 129. Canberra: AIHW.

ASC (Australian Sports Commission) 2001. Participation in exercise, recreation and sport 2001: annual report. Canberra: ASC.

ASC 2002. Participation in exercise, recreation and sport 2002: annual report. Canberra: ASC.

ASC 2003. Participation in exercise, recreation and sport 2003: annual report. Canberra: ASC.

ASC 2004. Participation in exercise, recreation and sport 2004: annual report. Canberra: ASC.

ASC 2005. Participation in exercise, recreation and sport 2005: annual report. Canberra: ASC.

ASC 2006. Participation in exercise, recreation and sport 2006: annual report. Canberra: ASC.

ASC 2007. Participation in exercise, recreation and sport 2007: annual report. Canberra: ASC.

ASC 2008. Participation in exercise, recreation and sport 2008: annual report. Canberra: ASC.

ASC 2009. Participation in exercise, recreation and sport 2009: annual report. Canberra: ASC.

ASC 2010. Participation in exercise, recreation and sport 2010: annual report. Canberra: ASC.

Austroads Ltd 2017. Australian cycling participation: results of the 2017 National Cycling Participation Survey. Sydney: Austroads Ltd.

Austroads Ltd 2019. A national approach to measuring non-fatal crash outcomes. Research Report AP-R599-19. Sydney: Austroads Ltd.

Barnett K, Mercer SW, Norbury M, Watt G, Wyke S & Guthrie B 2012. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. The Lancet 380:37–43.

Berry J & Harrison JE 2006. A guide to statistical methods for injury surveillance. Injury Technical Paper series no. 5. Adelaide, AIHW.

Britt HC, Harrison CM, Miller GC & Knox SA 2008. Prevalence and patterns of multimorbidity in Australia. Medical Journal of Australia 189(2):72–7.

Cryer C & Langley J 2006. Developing valid indicators of injury incidence for 'all injury'. Injury Prevention 12:202–7.

Cryer P, Westrup S, Cook AC, Ashwell V, Bridger P & Clarke C 2001. Investigation of bias after data linkage of hospital admissions data to police road traffic crash reports. Injury Prevention 7:234–41.

Gabbe B, Simpson PM, Harrison JE, Lyons RA, Ameratung S, Ponsford J et al. 2016. Return to work and functional outcomes after major trauma: who recovers, when, and how well? Annals of Surgery 263(4):623–32.

Gabbe BJ, Simpson PM, Sutherland AM, Wolfe R, Fitzgerald MC, Judson R et al. 2012. Improved functional outcomes for major trauma patients in a regionalized, inclusive trauma system. Annals of Surgery 255(6):1009–15.

Harrison JE & Steenkamp M 2002. Technical review and documentation of current NHPA injury indicators and data sources. Injury research and statistics series no. 14. Cat. no. INJCAT 47. Adelaide: AIHW.

Henley G & Harrison JE 2012. Trends in serious injury due to land transport accidents, Australia, 2000–01 to 2008–09. Injury research and statistics series no. 66. Cat. no. INJCAT 142. Canberra: AIHW.

Hollis S, Lecky F, Yates DW & Woodford M 2006. The effect of pre-existing medical conditions and age on mortality after injury. The Journal of Trauma 61(5):1255–60.

Holtslag HR, van Beek EF, Lindeman E & Leenen LPH 2007. Determinants of long-term functional consequences after major trauma. The Journal of Trauma 62(4):919–27.

Joseph B, Jokar TO, Hassan A, Azim A, Mohler MJ, Kulvatunyou N et al. 2017. Redefining the association between old age and poor outcomes after trauma: the impact of frailty syndrome. Journal of Trauma and Acute Care Surgery 82(3):575–81.

Langley JD, Dow N, Stephenson S & Kypri K 2003a. Missing cyclists. Injury Prevention 9:376–9.

Langley J, Stephenson S & Cryer C 2003b. Measuring road traffic safety performance: monitoring trends in nonfatal injury. Traffic Injury Prevention 4:291–6.

Loo BPY & Tsui KL 2007. Factors affecting the likelihood of reporting road crashes resulting in medical treatment to the police. Injury Prevention 13:186–9.

Lujic S, Finch C, Boufous S, Hayen A & Dunsmuir W 2008. How comparable are road traffic crash cases in hospital admissions data and police records? An examination of data linkage rates. Australian and New Zealand Journal of Public Health 32(1):28–33.

NCCC 2013. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 8th edn. Sydney: NCCC.

NCCH (National Centre for Classification in Health) 1998. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 1st edn. Sydney: NCCH.

NCCH 2000. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 2nd edn. Sydney: NCCH.

NCCH 2002. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 3rd edn. Sydney: NCCH.

NCCH 2004. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 4th edn. Sydney: NCCH.

NCCH 2006. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 5th edn. Sydney: NCCH.

NCCH 2008. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 6th edn. Sydney: NCCH.

NCCH 2010. The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian modification (ICD-10-AM). 7th edn. Sydney: NCCH.

Sluys K, Haggmark T & Iselius L 2005. Outcome and quality of life 5 years after major trauma. The Journal of Trauma 59(1):223–32.

StataCorp 2015. Stata statistical software: release 14. College Station, TX: StataCorp LP.

Stephenson S, Henley G, Harrison JE & Langley JD 2004. Diagnosis based injury severity scaling: investigation of a method using Australian and New Zealand hospitalisations. Injury Prevention 10:379–83.

Tochukwu C, Ikpeze MS, Glaun G, McCalla D & Elfar JC 2018. Geriatric cyclists: assessing risks, safety and benefits. Geriatric Orthopaedic Surgery & Rehabilitation 9:1–5.

Watson A, Watson B & Vallmuur K 2015. Estimating under-reporting of road crash injuries to police using multiple linked data collections. Accident Analysis & Prevention 83:18–25.

Weaver CM & Peacock M 2019. Skeletal changes across the life span. In: Burr DB & Allen MR (eds). Basic and applied bone biology (2nd edn). London: Academic Press.

WHO (World Health Organization) 2009. International statistical classification of diseases and related health problems, 10th revision (ICD-10). Geneva: WHO.

List of tables

List of figures

List of boxes

Related publications

The following AIHW publication, which contains information on pedal cycle injury, might also be of interest:

- AIHW (Australian Institute of Health and Welfare) 2015. Trends in serious injury due to road vehicle traffic crashes, Australia, 2001–2010. Injury research and statistics series no. 89. Cat. no. INJCAT 165. Canberra: AIHW.

In 2015–16, about 12,000 Australians were hospitalised for a pedal cycle-related injury representing 1 in 5 of injury hospitalisations from land transport crashes. Between 1999–00 and 2015–16, 651 pedal cyclists died as the result of their injuries, an average of 38 deaths per year. Rates of hospitalisations per year for age groups under 25 fell by 0.6%–4.2%, and rose by 5.4%–9.4% for those aged 25 and over.

aihw.gov.au

AIHW

Stronger evidence,
better decisions,
improved health and welfare