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Pedal cyclist hospitalisations: estimating on-road cases

Technical report
2000–01 to 2017–18

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2000–01 to 2017–18

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Summary

Findings of Stage 1 of the Austroads-funded development of linkage-based measurement of serious non-fatal road injuries in Australia raised the possibility that the method used in AIHW reports, including those prepared by the National Injury Surveillance Unit (NISU) for the Bureau of Infrastructure, Transport and Regional Economics (BITRE), could be improved by changing the way in which on-road cases are selected from among all records of hospitalised injury cases due to land transport crashes (Harrison et al. 2019).

In the linkage-based project, the cases specified as road injuries (apart from those in which hospital records were linked to crash records) were hospital cases included on the basis of the presence of *Place* codes that mean the injurious events occurred on a street or highway, rather than on the basis of *Traffic* codes, which have been the basis in most NISU reports.

The project report showed that the *Traffic* and *Place* methods could be expected to produce different results, particularly for cyclist cases, but did not examine the extent of the difference or other characteristics in detail. Pedal cyclists have become increasingly prominent among the cases included in reports of hospitalised road injuries in Australia.

This technical report examines the effects of using the *Traffic* and *Place* approaches to specify pedal cyclist road injury cases when using data from the National Hospital Morbidity Database (NHMD), which have been coded according to the Australian clinical modification of the 10th revision of International Classification of Diseases (ICD-10-AM) (ACCD 2017).

Overall, rates of hospitalised injury of cyclists according to the *Traffic* model were 1.2 to 1.3 times as high as rates for the *Place* model over the period from 2000–01 to 2017–18.

The *Traffic* and *Place* methods gave similar estimates of on-road cyclist cases for older adults; cases with a specified counterpart in collision; and cases that resulted in high threat to life injury, irrespective of age. Estimates were also similar for cases with hospital stays of longer than 2 days.

The *Traffic* method gave substantially higher estimates of on-road cases than the *Place* method for cases involving children. For children aged 0–4, rates using the *Traffic* model were 1.6 to 3.6 times as high as rates using the *Place* model, while for those aged 65 and rule over rates were similar for both models.

The *Traffic* method gave substantially higher estimates of on-road cases than the *Place* method for cases with no specified counterpart in collision.

Characteristics of the data tend to confirm a view that application of an ICD-10 coding rule accounts for much of the difference. The rule requires coders to use a *Traffic* code both for cases where the record indicates that the case occurred on-road, and for cases where the record is silent about place. The rule does not apply to *Place* coding. Coders following the rule would apply it to cases in which limited documentation of external cause left the place unknown (for example, 'Fell from pushbike'), a circumstance that is perhaps particularly likely to occur in cases that did not involve collision with a motor vehicle, did not result in a severe injury, or in which the cyclist was a child.

The *Traffic* method overestimates on-road cyclist cases. The *Place* method should not overestimate on-road cases but has the weakness that it does not include the truly on-road cases that can expected to be among the cases for which place is unspecified. Ways to improve measurement in future are proposed.

1 Introduction

Overview

Findings of Stage 1 of the Austroads-funded development of linkage-based measurement of serious non-fatal road injuries in Australia raised the possibility that the method used in AIHW reports, including those prepared by the National Injury Surveillance Unit (NISU) for the Bureau of Infrastructure, Transport and Regional Economics (BITRE), could be improved by changing the way in which on-road cases are selected from among all records of hospitalised injury cases due to land transport crashes (Harrison et al. 2019).

In the linkage-based project, the cases specified as road injuries (apart from those in which hospital records were linked to crash records) were hospital cases included on the basis of the presence of *Place* codes that mean the injurious events occurred on a street or highway, rather than on the basis of *Traffic* codes (Harrison et al. 2019). The project report showed that the *Traffic* and *Place* methods could be expected to produce different results, particularly for cyclist cases, but did not examine the extent of the difference or other characteristics in detail.

This technical report examines the effects of using the *Traffic* and *Place* approaches to specify pedal cyclist road injury cases when using data from the National Hospital Morbidity Database (NHMD), which have been coded according to the Australian clinical modification of the 10th revision of International Classification of Diseases (ICD-10-AM) (ACCD 2017).

Key concepts and terms

Traffic and non-traffic codes

In keeping with common practice, AIHW reports have usually treated the ICD-10-AM *Traffic* construct as equivalent, or nearly equivalent, to the road safety sector construct 'on-road'. This follows from the first part of the ICD-10 definition of the phrase 'traffic accident':

A traffic accident is any vehicle accident occurring on the public highway [that is, originating on, terminating on, or involving a vehicle partially on the highway]. (ACCD 2017; WHO 2016).

When applying the *Traffic* approach for AIHW reports, a record is included if the first (left-most) ICD-10-AM External Cause code in it is from the set applicable to unintentional land transport crashes (that is, codes beginning with 3-character codes in the range from V00 to V89) and the code rubric includes the phrase 'traffic accident'. When the focus is pedal cyclist cases, the relevant *Traffic* codes are those in which the 3 characters V10 to V18 are followed by 4th characters 4, 5 or 9, plus those that begin with V19 and have 4, 5, 6 or 9 as the 4th character.

The ICD-10 (and ICD-10-AM) definition quoted above continues as follows:

A vehicle accident ***is assumed to have occurred on the public highway unless another place is specified****, except in the case of accidents involving only off-road motor vehicles, which are classified as non-traffic unless the contrary is stated.*

A later passage specifies that the assumption (bolded text) applies to pedal cyclists as well as to occupants of motor vehicles (with the limited exception of certain types of motor vehicles designed for off-road use). The assumption does not apply to pedestrians.

This assumption means that when a cyclist is injured in a crash and the location of the crash is not specified in the information available to the coder, then the event should be coded as having occurred in *Traffic*. Cases in which the *Traffic* code was assigned because of this rule might not have truly occurred on-road, with the effect of overestimating the number of on-road pedal cyclist injuries. The NHMD does not record whether a *Traffic* code was assigned on the basis of information seen by the coder on where the crash occurred, or on the basis of the assumption that coders are required to make if information is lacking.

The ICD-10 rule reflects somewhat limited expectations for the reliability of external cause coding and the information on which the coding is based. The rule is needed only if records are silent on whether a land transport case occurred on-road. Assumptions underlying the rule are that the mode of transport of the injured person is a good predictor of whether the case will have occurred on-road, and that it is better to supply data relying on that prediction rather than data that acknowledge ignorance of where some cases actually occurred.

Even in Australia, where the admitted patient morbidity data collection is an important administrative system, and where there is a long tradition of coding external causes of injury as part of it, the external causes information in hospital records and coding of it have considerable limitations (McKenzie et al. 2009). While place and mechanism of occurrence are often spelled out, some records offer the coder no more than a phrase like 'fell from pushbike'.

Unlike most crashes involving motor vehicles, a substantial proportion of crashes involving cyclists are reported to occur in an off-road setting. For example, the report cited above found that 41% of hospitalisations involving cyclists were coded as occurred in a non-traffic setting (AIHW: Kreisfeld & Harrison 2019). Off-road cases were particularly common among children. The ICD-10 defaulting rule does not require coders to make an assumption when assigning non-traffic codes.

Place of occurrence codes

The NHMD provides another basis for deciding whether injuries of land transport users occurred on-road, namely the place of occurrence fields. The ICD-10-AM *Place* code Y92.4 means that the incident occurred on a street or highway. The scope of Y92.4 includes footpaths and cycleways adjacent to a road. It does not include driveways and car parks. This code has not commonly been used to distinguish between on-road and off-road crashes.

Use of ICD-10-AM place code Y92.4 should not be affected by the 'default to traffic' rule described above, as the rule does not apply to place coding. Hence, a coder processing a record that notes that the injured person was a cyclist, but provides no information on where the injurious crash occurred, should assign a place code meaning 'unspecified', even though the defaulting rule's assumption requires the coder to assign an external cause code with *Traffic* in its label.

Among NHMD injury records overall, place is often unspecified, potentially making place a poor basis for selecting 'on-road' cases. This is a reason why place codes have not been used for this purpose more often. However, in the Stage 1 linkage-based project (in which crash records were taken to refer only to on-road cases), over 94% of hospital records that were matched to a crash record had a place code meaning '*Street and highway*' and another 2% had codes for other specified places, some of which are consistent with an event that occurred at least partly on a road. Less than 4% of the hospital records linked with a crash record had a code meaning unspecified place.

Place codes were used in the project as the basis for deciding which hospitalised cases of land transport injury that had not been linked to a crash record should be considered to have occurred on-road. This process was particularly important for pedal cyclist cases, over 70% of which were based only on hospital data (compared with under 19% of motor vehicle driver cases).

The place-based method has the desirable property of not assigning cases as *Traffic* on the basis of codes that might have been assigned because of the defaulting rule, rather than because the record provided information that the event occurred on-road. However, place codes are not perfect (for example, place is unspecified for some cases, and some place categories are ambiguous as to whether they refer to an on-road event). Also, some cases with a *Traffic* code and unspecified place might truly have occurred on-road.

Aim and methods for this report

Between 1999–00 and 2015–16, nearly 160,000 people were hospitalised in Australia because of injuries sustained while riding a pedal cycle, with 12,000 hospitalisations occurring in 2015–16 (AIHW: Kreisfeld & Harrison 2019). Cyclist case numbers and population-based rates have risen over time and become more prominent among the cases included in reports of all hospitalised road injuries in Australia (AIHW: Kreisfeld & Harrison 2019). The cases included as 'on-road' in these reports were selected according to the *Traffic* approach (AIHW: Kreisfeld & Harrison 2019; AIHW: Henley & Harrison 2015).

This technical report was undertaken to examine further the matter of how to estimate 'on-road' cases when the basis for reporting is ICD-10-AM coded hospital records, particularly when the records are not linked internally (that is, to identify which records refer to the same person), or externally (with crash data).

Cyclists were chosen as the focus for the report because (1) pedal cycling and pedal cycle crashes commonly occur in places other than roads, particularly at young ages; (2) previous work, generally using the *Traffic* approach, has found rising numbers and population-based rates of on-road cyclist hospitalisations; and (3) cyclists comprised 43% of 'doubtfully on-road' hospitalised injury cases in the Stage 1 project (that is, hospitalised land transport injury cases that were not matched to a crash record and did not have *Place* code of 'S*treet and highway'*.)

Data used in this report

This report is based on case data from the NHMD. Almost all episodes of admitted patient care in Australia are included in the NHMD and the cases have been coded according to the ICD-10-AM (ACCD 2017). ICD-10-AM codes in NHMD records include external causes of injury (the main block of codes, plus codes on place of occurrence and activity when injured) as well as diagnosis codes. Further information on case inclusion and coding is provided in Appendix A.

This report does not include cases reported in national deaths data because that source does not provide information on place of occurrence. In the period 1999–00 to 2015–16, 651 people died from injuries sustained while riding a pedal cycle, an average of 38 deaths per year (AIHW: Kreisfeld & Harrison 2019).

Population-based rates were calculated using Estimated Resident Population data from the Australian Bureau of Statistics (ABS).

NHMD records were included in this report if they met all parts of the following selection criterion:

- an episode of care as an admitted patient that occurred in Australia and ended (that is, separation from hospital occurred) from 1 July 2000 to 30 June 2018;
- had a principal diagnosis code in the range S00–T75 or T79 of ICD-10-AM Chapter XIX *Injury, poisoning and certain other consequences of external causes*;
- 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; and
- mode of admission was not a transfer from another acute hospital.

The term *Pedal cyclist,* which appears in the ICD-10-AM categories included in this report, is defined as 'any person riding on a pedal cycle or in a sidecar or trailer attached to such a vehicle'. ICD-10-AM defines pedal cycle as 'any land transport vehicle operated solely by pedals' and as including bicycles and tricycles and excluding 'Motorised bicycles'. While 'e-bike' and similar terms are not mentioned in ICD-10-AM, the definition of pedal cycle implies that they are out of scope. However, since e-bikes are often similar to pedal cycles, some injured e-bike riders might have been coded as pedal cyclists.

The term 'cyclist' is sometimes used in this report in place of 'pedal cyclist', for brevity. 'Motorcyclist' is not shortened, to avoid ambiguity.

Further information about data and methods is provided in Appendix A.

Models considered

Five approaches to describing hospitalised pedal cyclist injury cases are used in this report:

All pedal cyclist cases—all cases meeting the criteria given above. This includes all cases recorded as being cyclists injured in land transport events with no attempt to restrict them to episodes that occurred on-road.

Traffic—pedal cyclist cases meeting the criteria given above in which the first-occurring ICD-10-AM external cause code in the NHMD record indicates that the injured cyclist was a cyclist 'injured in traffic accident'.

Place—pedal cyclist cases meeting the criteria given above in which an ICD-10-AM *Place of occurrence* code in the hospital record is Y92.4, *Street and highway*.

Traffic and place—pedal cyclist cases meeting the criteria given above in which the first-occurring external cause code means pedal cyclist 'injured in traffic accident' and in which a *Place of occurrence* code is present that means '*Street and highway'*.

BITRE—Statistical reports on serious road injury produced by the AIHW for the Bureau of Infrastructure, Transport and Regional Economics (BITRE) apply selection criteria that differ slightly from those used in other AIHW injury reports, though they are very similar to the *Traffic* model described above. Chapter 4 demonstrates this similarity by comparing cyclist case counts according to the BITRE criteria with cyclist counts according to the *Traffic* model used elsewhere in this report.

Structure of this report

Chapter 2 compares and contrasts the use of different criteria to delineate between cyclist cases occurring in on-road and off-road settings. This mainly involves comparison of the *Traffic* and *Place* approaches.

Chapter 3 briefly examines the *Traffic* and *Place* approaches in relation to marked fluctuations in trends in rates of cyclist injuries following changes in jurisdictional administrative procedures relating to hospital admissions.

Chapter 4 provides an overview of the small difference between the *Traffic* approach as used in this report and the criteria used to provide traffic crash data to the Bureau of Infrastructure, Transport and Regional Economics (BITRE).

Chapter 5 provides a discussion of findings and recommendations.

Appendix A provides information on the data and methods used.

Appendix B contains a data quality statement on the National Hospital Morbidity Database.

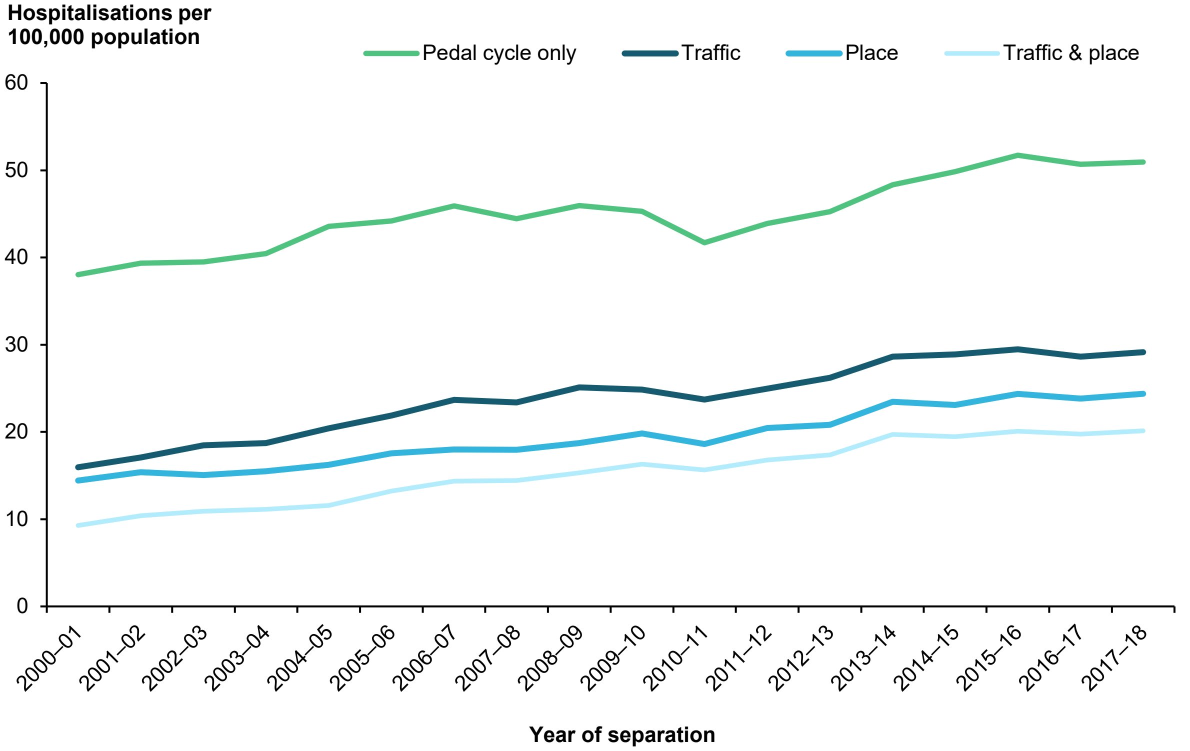
2 Determination of on-road pedal cycle crashes

The purpose of this chapter is to compare and contrast the use of different criteria to delineate between pedal cyclist injuries occurring in on-road and off-road settings. Comparisons are made using the first 4 models outlined in the introduction to this report. Most of the comparisons involve the *Traffic* and *Place* models since the *Traffic* model is currently used in most NISU reports when estimating on-road cyclist serious injury cases and the *Place* model is the most direct alternative basis for estimating the same thing.

Overview

Figure 2.1 shows rates of cyclist hospitalisations for 4 models from 2000–01 to 2017–18. All 4 models show a relatively linear increase over this period. Rates for the *Traffic* model were 1.2 to 1.3 times as high as rates for the *Place* model over most of this period.

Figure 2.1: Age-standardised rates of pedal cyclist hospitalisations for 4 models, 2000–01 to 2017–18



Note: Data underpinning this figure are available in the supplementary table spreadsheet Table S2.1.

Among the 172,888 cyclist cases meeting the report inclusion criteria, almost 54% (*n* = 93,161) were coded as *Traffic*. As might be expected, those with *Place* code of '*Street and highway'* (*n* = 75,896) were particularly likely to be coded *Traffic*, at 80%. Among the '*Street and highway'* cases, the proportion coded as *Traffic* was even higher for the 32,599 with a specified counterpart (91%). The presence of specific codes for place and counterpart in these cases is consistent with the interpretation that coding was based on informative records, which might also have provided an indication of whether the crash had occurred on-road, thus obviating a need to rely on the defaulting rule.

Young children are generally discouraged from cycling on roads. That is reflected in the pattern of information on place of occurrence for cyclist cases aged 12 or under, in which about the same numbers were recorded as occurring on a '*Street and highway'* (*n* = 8,788; 66% *Traffic*) and at other specified types of place (*n* = 8,310; 10% *Traffic*). However, most hospitalised cases among children occurred at an unspecified place (*n* = 22,596; 57%). About one-third of these cases (7,434) also lack information on the counterpart. Strikingly, 70% of these cases were coded *Traffic* (probably often on the basis of the defaulting rule), compared with 62% of child cases with a *Place* code of '*Street and highway'*.

Age

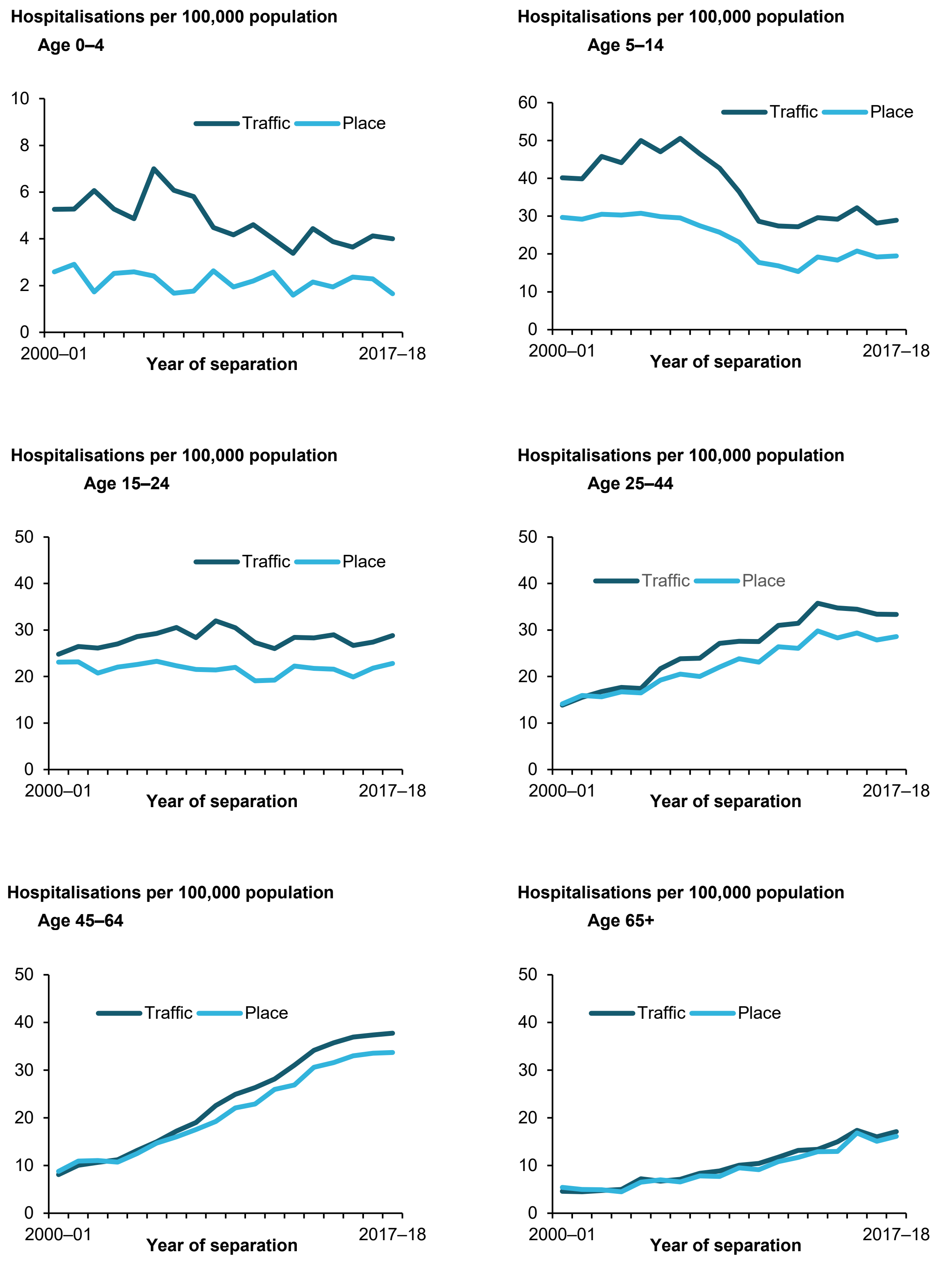
Figure 2.2 shows rates of cyclist hospitalisations for the *Traffic* and *Place* models over the period 2000–01 to 2017–18 by age group. Notably, rates were higher for the *Traffic* model than the *Place* model in the younger age groups, the difference tending to reduce for older age groups. For example, for children aged 0–4, rates using the *Traffic* model were 1.6 to 3.6 times as high as rates using the *Place* model over the period of interest, while for those aged 65 and over, rates were similar for both models.

This pattern is probably explained by children being more likely than older groups to ride pedal cycles in off-road settings. Children are not prohibited from cycling on roads in Australia, but it is discouraged, especially for young children. Laws restricting cycling on footpaths have been relaxed, particularly for children in some jurisdictions.

Reflecting this, the younger the child cyclist, the more likely it is that he or she was injured while riding off-road. This suggests that the *Traffic* model is overestimating the number of injuries occurring in on-road settings to children and to some degree younger adults.

Notably for both models, rates in children and younger adults either decreased or remained relatively steady over time, while rates in older age groups tended to increase markedly over time. These observations are in line with what has been reported previously (for example, Henley & Harrison 2012).

Figure 2.2: Pedal cyclist hospitalisation rates, by age and model, 2000–01 to 2017–18



Notes

1. Data underpinning this figure are available in the supplementary table spreadsheet Table S2.2.
2. Vertical scales across charts vary due to marked differences in rates for different age groups.

Source: AIHW NHMD.

State or territory of hospitalisation

Figure 2.3 shows rates of cyclist hospitalisations for the *Traffic* and *Place* models from 2000–01 to 2017–18 by state or territory of hospitalisation. Apart from the Northern Territory, rates were significantly higher for the *Traffic* model than the *Place* model for most of the period of interest.

For some jurisdictions, both models produced similar rates early in the period. The reason for this is unclear but may be linked to differences between jurisdictions in the way these cases were coded. Notably, both models produced similar patterns over time with rises and falls in rates occurring in the same years. Most jurisdictions showed increases in rates over time, apart from Tasmania and the Northern Territory where rates were relatively steady over time.

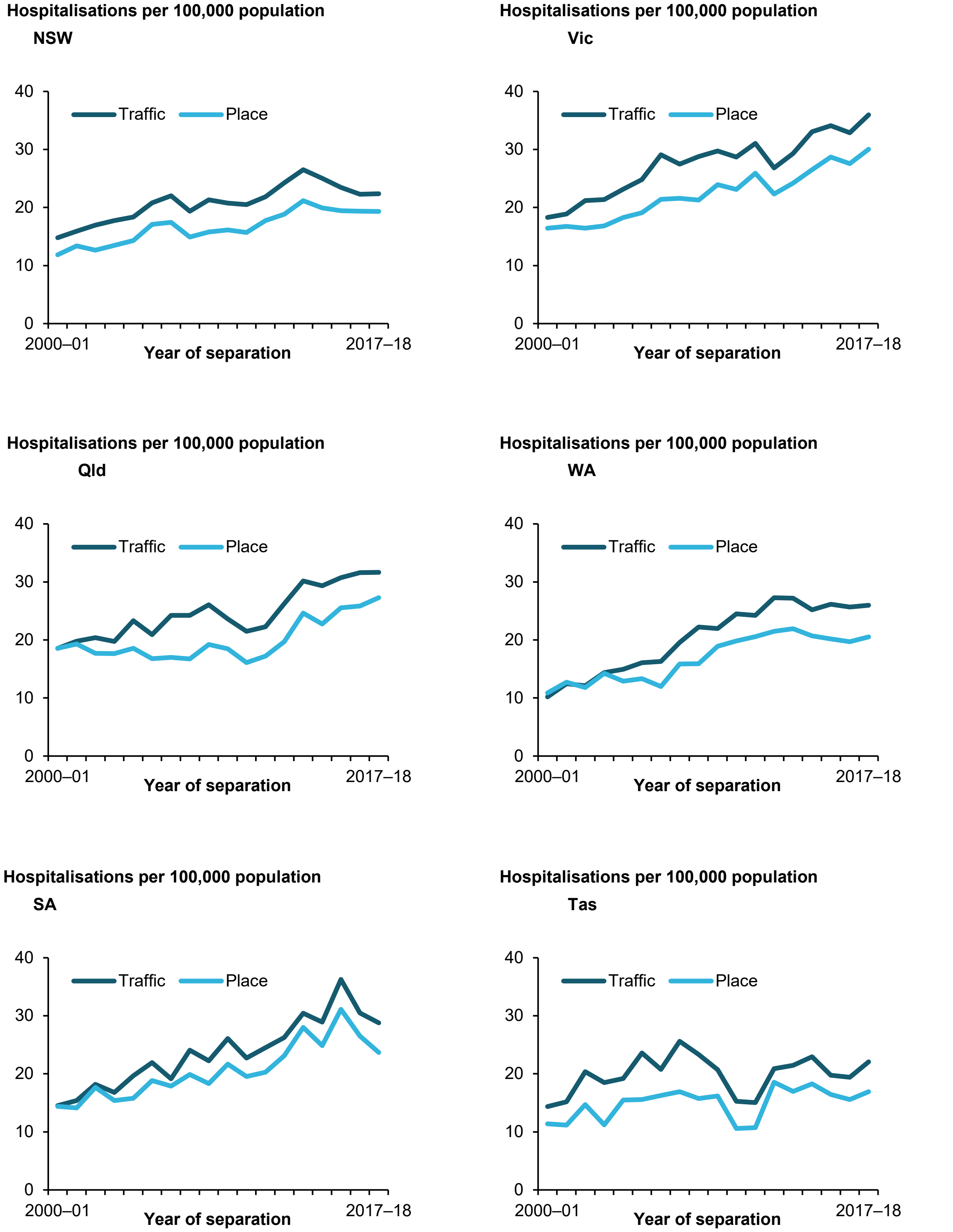
It is not clear why both models produced similar rates in the Northern Territory. Possibly, there were fewer cases where the location of the pedal cycle crash was unspecified than for other jurisdictions.

Rates were noticeably higher over most of the charted period in the Australian Capital Territory when compared with other jurisdictions. According to national cycling surveys, the Australian Capital Territory has one of the highest rates of cycling participation of all jurisdictions, which may partially account for the higher rates (NCPS 2020). A similar pattern was observed when limited to cases classified as high threat to life, with rates in the Australian Capital Territory noticeably higher than for other jurisdictions over most of the charted period.

The impact of hospital administrative admission policies in Victoria from 2012–13 onwards and New South Wales from June 2017 onwards on trends over time is discussed in Chapter 3. Issues with external cause coding in New South Wales private hospitals in 2015–16 and 2016–17 are also discussed in Chapter 3.

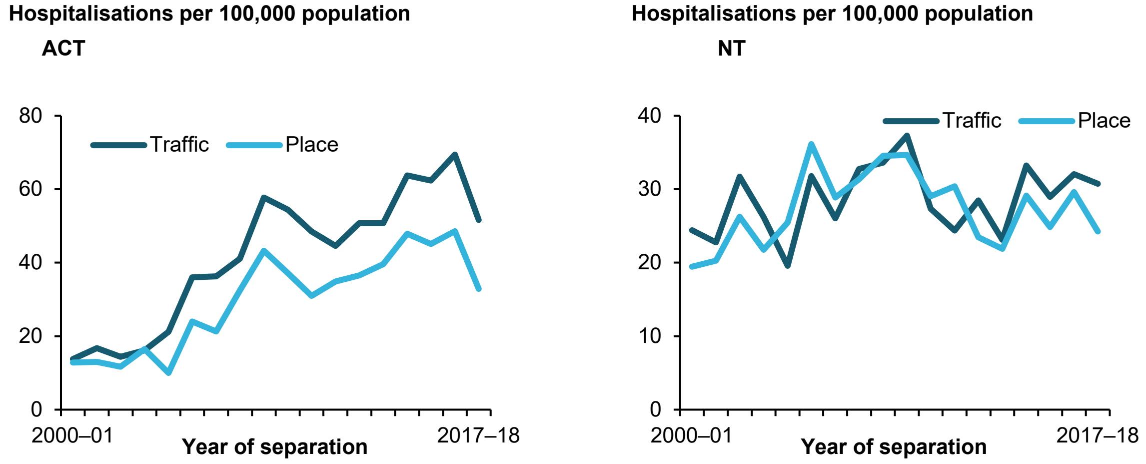
In most NISU reports the focus is on estimated incidence rates. Where incidence rates are reported by state and territory, the most appropriate basis for grouping cases by jurisdiction is the place of usual residence of the admitted person. In this report a topic of interest is possible effects on pedal cyclist case numbers of differences between jurisdictions in hospital admission policies. State or territory of admission is relevant in that context, and has been used basis for grouping cases by jurisdiction in this report.

Figure 2.3: Pedal cyclist hospitalisation rates, by state or territory of hospitalisation and by model, 2000–01 to 2017–18



(continued)

Figure 2.3 (continued): Pedal cyclist hospitalisation rates, by state or territory of hospitalisation and by model, 2000–01 to 2017–18



Notes

1. Data underpinning this figure are available in the supplementary table spreadsheet Table S2.3.
2. Vertical scales across charts vary due to differences in rates for different age groups.

Source: AIHW NHMD.

Counterpart in collision

Figure 2.4 shows rates of cyclist hospitalisations for the *Traffic* and *Place* models from 2000–01 to 2017–18 by the counterpart in the collision. Both models produced very similar rates over time when the counterpart in the collision was a car, pickup truck or van, another pedal cycle or a pedestrian. These types of collisions are likely to occur in an on-road setting. This appears to suggest that records that document a specific counterpart also tend to document whether the crash occurred on-road.

Rates for collisions with fixed or stationary objects were moderately higher when using the *Place* model.

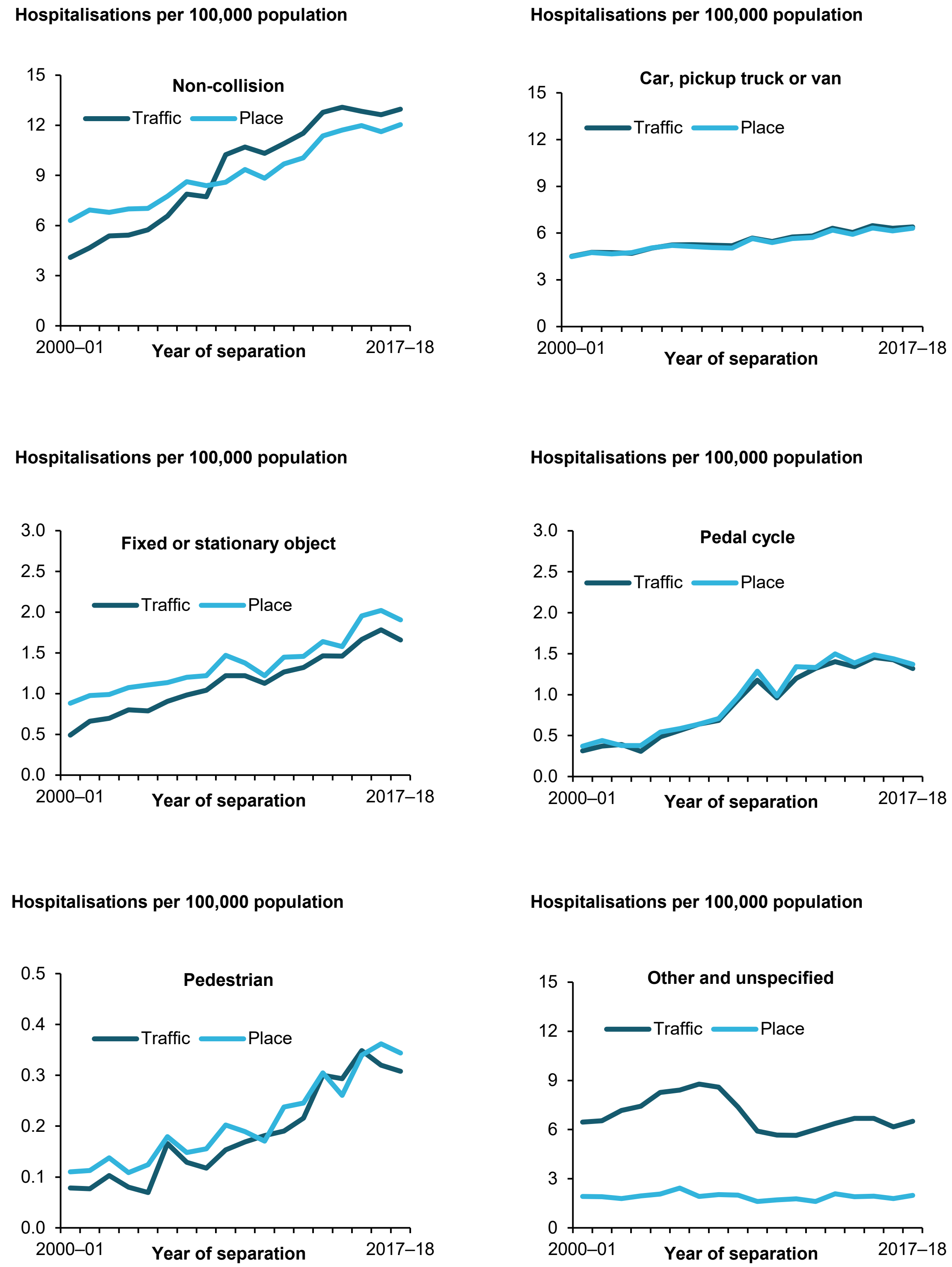
An unusual pattern was observed for non-collision crashes in that rates were higher for the *Place* model until 2007–08 after which rates were higher for the *Traffic* model. Notably, rates increased steadily over the charted period for the *Place* model, while for the *Traffic* model, rates increased steadily over the charted period apart from a marked upward step between 2007–08 and 2008–09.

The upward step in non-collision rates between 2007–08 and 2008–09 coincided with a marked drop in rates for cases where the counterpart in the collision was classified as *Other or unspecified*. The drop was most prominent in the most populous jurisdictions, especially Queensland and Victoria, and for younger age groups.

ICD-10-AM categories and rules did not change in ways that might explain these sudden changes in rates.

Rates for other and unspecified counterparts in collisions were generally 3 to 4 times as high for the *Traffic* model as for the *Place* model over the period of interest. This is likely to reflect lack of detail in the records. That is, records with unspecified counterpart and unspecified place of occurrence (for example, ‘Pedal cycle crash’) will be included by the *Traffic* model (because of the defaulting rule) but not by the *Place* model.

Figure 2.4: Pedal cyclist hospitalisation rates, by counterpart in collision and model, 2000–01 to 2017–18



Notes

1. Data underpinning this figure are available in the supplementary table spreadsheet Table S2.4.
2. Vertical scales across charts vary due to marked differences in rates for different counterparts.

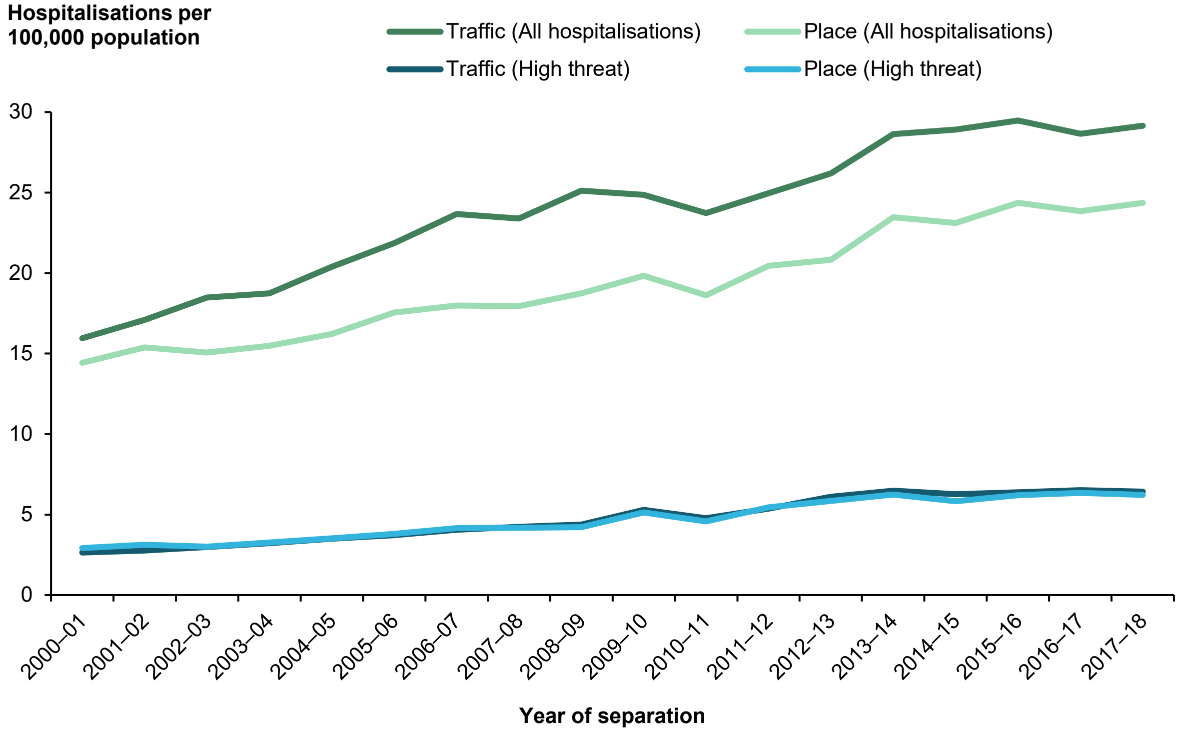
Source: AIHW NHMD.

High threat to life

Figure 2.5 shows rates of cyclist hospitalisations for all cases and high threat to life cases for the *Traffic* and *Place* models from 2000–01 to 2017–18. When all cases were considered, rates based on the *Traffic* model were markedly higher than rates using the *Place* model. In contrast, both models produced very similar rates over this period when attention was limited to high threat to life cases. (See Appendix A for the method used to specify 'high threat to life'.)

Pedal cycle collisions resulting in severe injuries are likely to occur on-road and this might account for the observed similarity in rates. Perhaps cases that resulted in more serious injuries also tend to be better documented. Previous work has found that ambulance records of injury cases tend to be informative about external causes (McKenzie et al. 2009), and cases with severe injuries are likely to have been transported by ambulance.

Figure 2.5: Pedal cyclist hospitalisation rates for all hospitalisations and high threat to life hospitalisations, 2000–01 to 2017–18



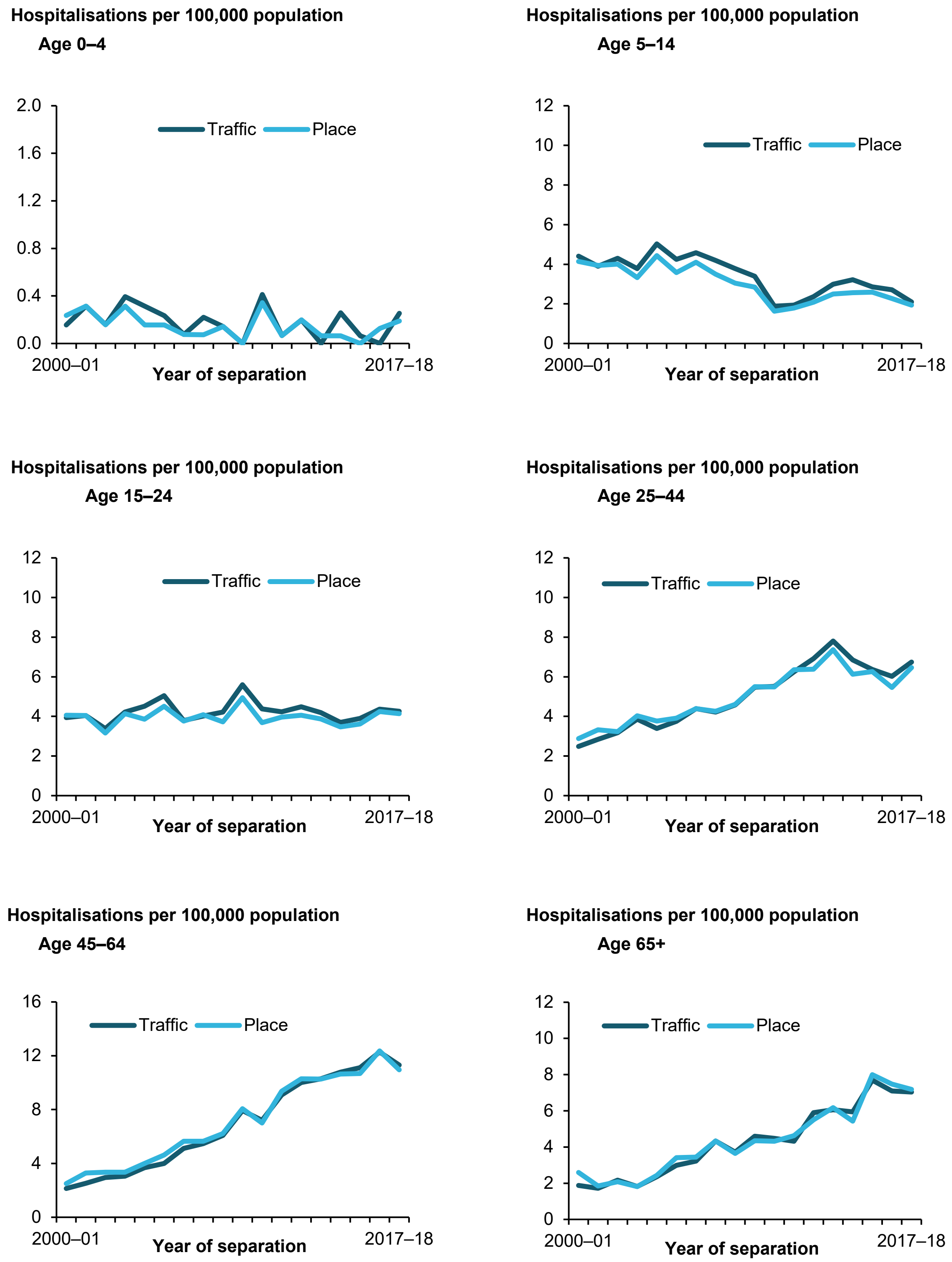
Note: Data underpinning this figure are available in the supplementary table spreadsheet Table S2.5.

Age and threat to life

Figure 2.6 shows rates of cyclist hospitalisations for high threat to life cases for the *Traffic* and *Place* models from 2000–01 to 2017–18 by age group (compare with Figure 2.2, which also includes low threat to life cases). Both models produced very similar rates over this period for all age groups. Again, increases in rates over time were more pronounced in older age groups.

Overall, it appears that overestimation of rates for cyclist hospitalisations as being due to on-road crashes is markedly reduced when considering only high threat to life cases. Perhaps these cases tend to be better documented than those with less severe injuries.

Figure 2.6: Pedal cyclist hospitalisation rates for high threat to life cases, by age and model, 2000–01 to 2017–18



Notes

1. Data underpinning this figure are available in the supplementary table spreadsheet Table S2.6.
2. Vertical scales across charts vary due to marked differences in rates for different age groups.

Source: AIHW NHMD.

Hospital sector

Figure 2.7 shows rates of cyclist hospitalisations for the *Traffic* and *Place* models from 2000–01 to 2017–18 by whether the patient was admitted to a public or a private hospital. The pattern of rates for public hospitals was similar to that for all hospitals (see Figure 2.1) in that rates using the *Traffic* model were generally about 1.2 to 1.3 times as high as rates using the *Place* model. This is to be expected since public hospitals over this period accounted for close to 92% of all cyclist hospitalisations.

There was a more marked difference in rates between the 2 models for private hospitals where rate using the *Traffic* model was generally around 1.5 to 1.6 times as high as rates using the *Place* model over the period of interest. This suggests that rates for cyclist crashes occurring in an on-road setting are likely to be overestimated more in data from private hospitals than in public hospital data.

This might be explained by a tendency for private hospital records to provide less specific information on external cause of injury than public hospital records, resulting in more use of the defaulting rule and greater overestimation of 'in traffic' cases.

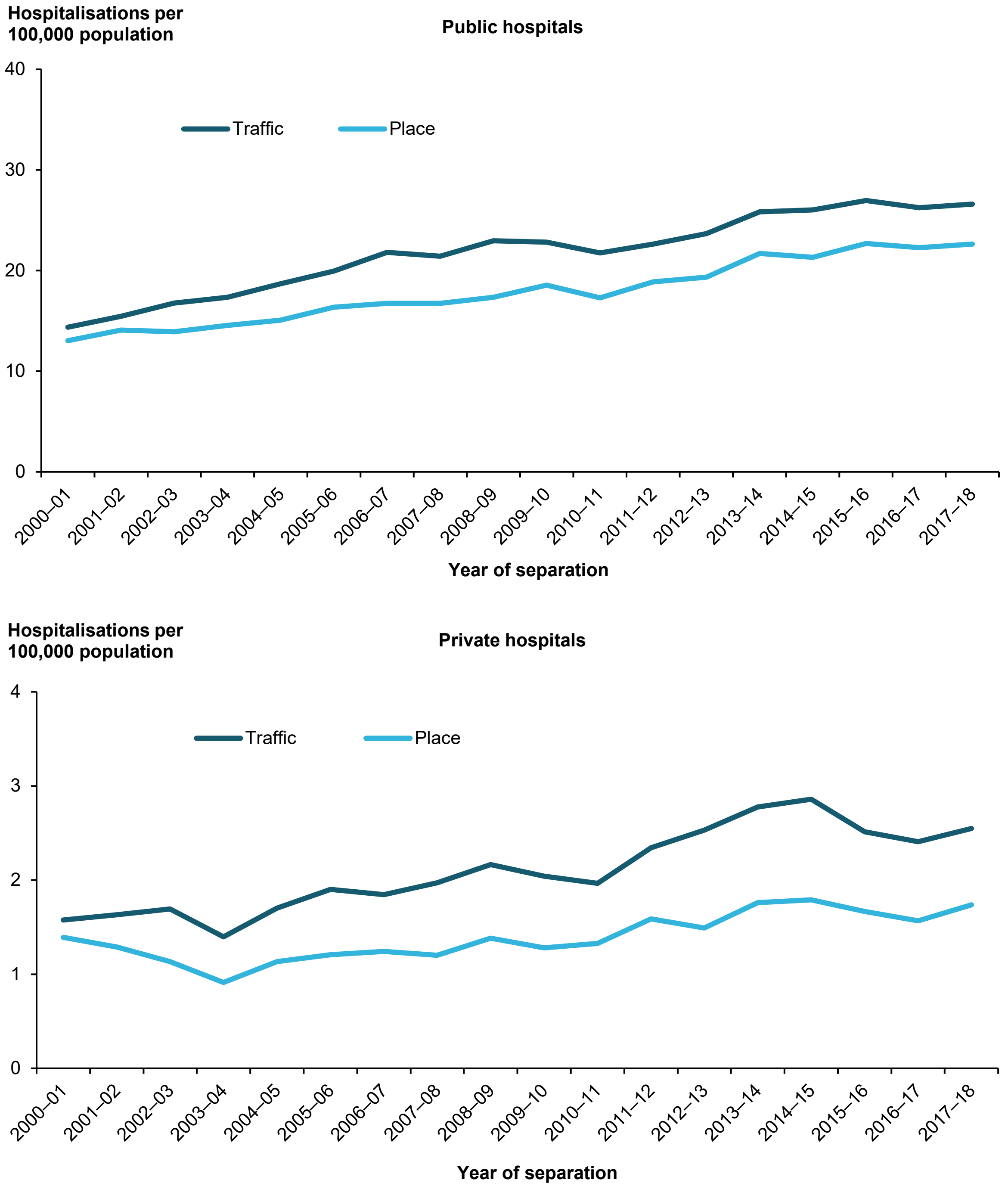
Information on counterpart provides an indication of less specificity in private hospital coding (Table 2.1). Counterpart was *Other and unspecified* for 50% of private hospital cyclist cases and for 22% of public hospital cases.

Issues with external cause coding in New South Wales private hospitals in 2015–16 and 2016–17 are discussed in Chapter 3.

Table 2.1: Pedal cyclist hospitalisations included by counterpart in collision by hospital sector, 2000–01 to 2017–18

	Public hospital		Private hospital	
Counterpart in collision	**Count**	**%**	**Count**	**%**
Car, pickup truck or van	20,859	21.2%	1,133	11.2%
Heavy transport vehicle or bus	987	1.0%	34	0.3%
2 or 3-wheeled motor vehicle	224	0.2%	14	0.1%
Pedestrian or animal	898	0.9%	82	0.8%
Pedal cycle	4,162	4.2%	311	3.1%
Railway train or vehicle	34	0.0%	4	0.0%
Other non-motor vehicle	104	0.1%	15	0.1%
Fixed or stationary object	5,674	5.8%	239	2.4%
Non-collision	43,440	44.2%	3,228	31.8%
Other and unspecified	22,001	22.4%	5,084	50.1%
Total	**98,383**	**100**	**10,144**	**100**

Figure 2.7: Pedal cyclist hospitalisation rates by hospital sector and model, 2000–01 to 2017–18



Notes

1. Data underpinning this figure are available in the supplementary table spreadsheet Table S2.7.
2. Vertical scales across charts vary due to marked differences in rates for hospital sectors.

Source: AIHW NHMD.

Length of stay in hospital

Overview

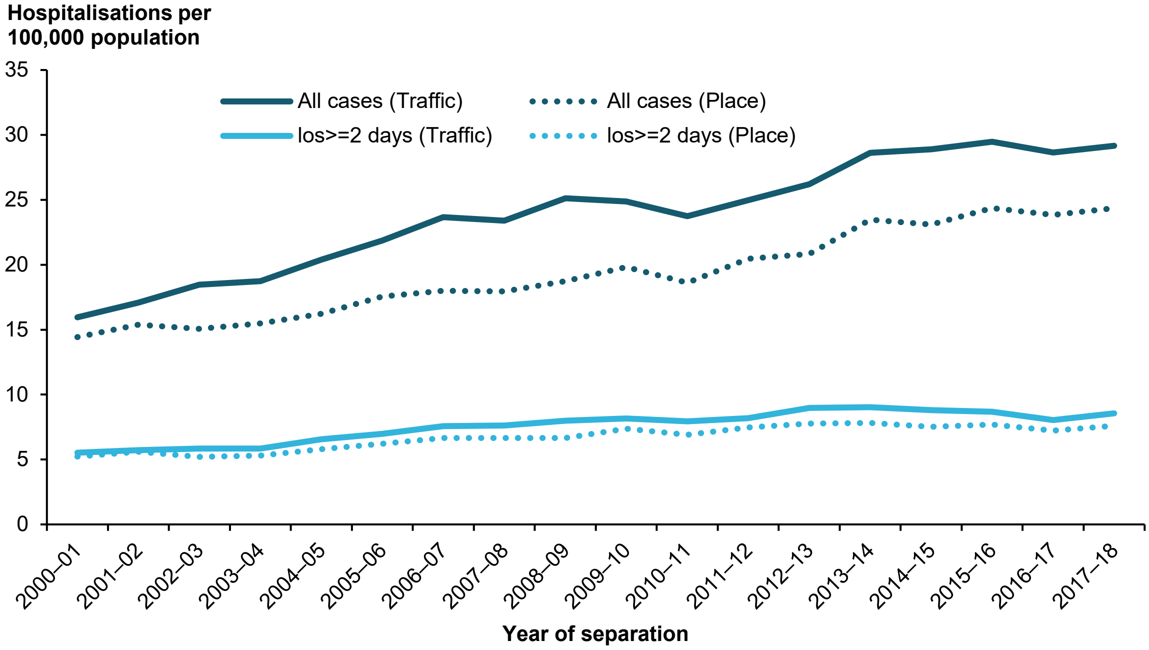
Figure 2.8 shows rates of cyclist hospitalisations for the *Traffic* and *Place* models from 2000–01 to 2017–18 by whether the patient spent at least 2 days in hospital as an admitted patient. The difference in rates over time between the *Traffic* and *Place* models is much greater for hospitalised cases with any length of stay than for cases where length of stay in hospital is greater than or equal to 2 days.

For all hospitalisations, the rates using the *Traffic* model were 1.2 to 1.3 times as high as when using the *Place* model, while for hospitalisations where length of stay was 2 days or longer, rates using the *Traffic* model were 1.1 to 1.2 times as high as when using the *Place* model. Hence, it appears that excluding cases with a length of stay in hospital of 1 day or less reduces the overestimation of rates for on-road cases.

One of the reasons that excluding cases with a length of stay of 1 day or less reduces an overestimation of rates for on-road cases may be that that this method results in a higher proportion of high threat to life cases. Table 2.2 summarises cyclist hospitalisations for the *Traffic* model from 2000–01 to 2017–18 by whether or not the case was high threat to life and whether or not the length of stay was greater than or equal to 2 days. For hospitalisations with the longer length of stay, over 40% were classified as high threat to life, while for cases with the shorter length of stay, just over 11% were classified as high threat to life.

Broadly, longer length of stay tends to imply greater case severity and so the presentation here can be seen as being related to that in the high threat to life section, above. However, length of stay as presented here has a complex relationship with case severity because analysis is in terms of episodes of care. A severe case might have a short episode of care at one hospital before being transferred to another hospital for further care. Also, very severe cases might die in hospital, perhaps after a short stay.

Figure 2.8: Pedal cyclist hospitalisation rates by length of stay in hospital and model, 2000–01 to 2017–18



Note: Data underpinning this figure are available in the supplementary table spreadsheet Table S2.8.

Table 2.2: Pedal cyclist hospitalisations by high threat to life, by length of stay using Traffic model, 2000–01 to 2017–18

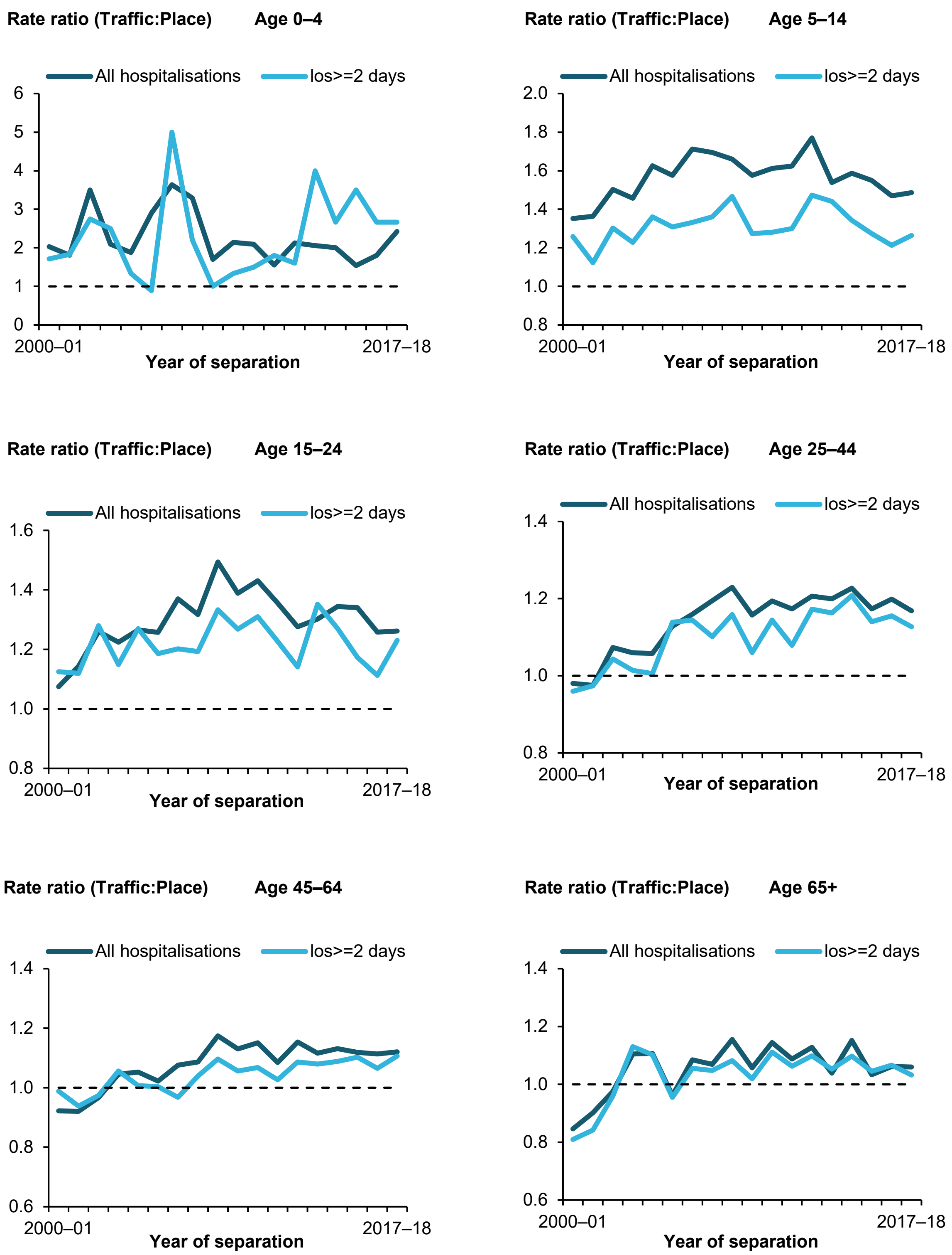
	Length of stay in hospital			
	<= 1 day		>= 2 days	
High threat to life	**Count**	**%**	**Count**	**%**
No	56,258	88.9	17,773	59.5
Yes	7,016	11.1	12,114	40.5
Total	**63,274**	**100**	**29,887**	**100**

Age group

Figure 2.9 shows rate ratios for the *Traffic* compared to *Place* models of cyclist hospitalisations by age group and by whether or not the patient was admitted to hospital for 2 days or longer. If rates for the 2 models (*Traffic* and *Place*) are the same, then the ratio is 1 (dashed line). Ratios above 1 indicate that the *Traffic* model gave a higher rate than the *Place* model.

For all age groups and for nearly all years, rate ratios were higher for all hospitalisations than for hospitalisations which excluded cases where length of stay was 1 day or less. The largest difference in rate ratios was observed for children aged 5–14, while differences in other age groups were broadly similar. Interestingly, the smallest differences in rate ratios appeared to be in children aged 0–4. However, for this age group there was a high degree of fluctuation of rate ratios from year to year.

Figure 2.9: Pedal cyclist rate ratios by model, by age and length of stay in hospital, 2000–01 to 2017–18



Notes

1. Data underpinning this figure are available in the supplementary table spreadsheet Table S2.9.
2. Vertical scales across charts vary due to marked differences in ratios for different age groups.

Source: AIHW NHMD.

These observations suggest that the exclusion of cases with a length of stay of 1 day or less appears to reduce the overestimation of pedal cycle hospitalisations attributed to on-road crashes in most age groups, apart from children aged 0–4 and those aged 65 and over.

State or territory of hospitalisation

Figure 2.10 shows rate ratios for the *Traffic* compared to *Place* models of cyclist hospitalisations from 2000–01 to 2017–18 by state or territory of hospitalisation and by whether or not the patient was admitted to hospital for 2 days or longer.

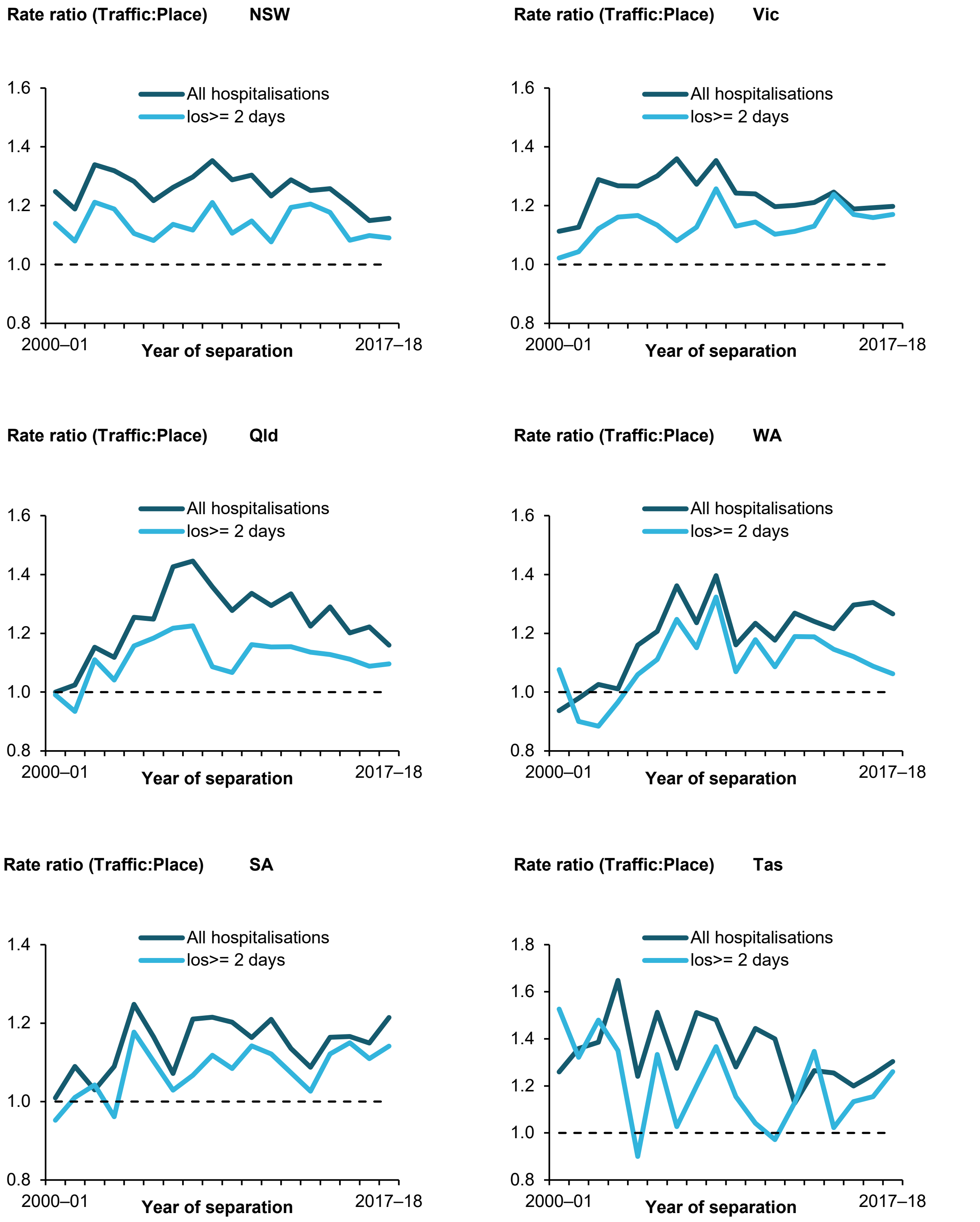
The ‘all hospitalisations’ lines are based on the same data as underlie Figure 2.2. As shown there, *Traffic*-based rates were generally higher than *Place*-based rates, especially at younger ages.

In general, restriction of cases to those with 2 days or longer stay resulted in *Traffic*-based rates that were closer to the corresponding *Place*-based rates than when all cases were included, though the *Traffic*-based generally remained higher than the *Place*-based rates (Figure 2.10).

The difference between results based on all cases and those after omitting same-day cases was most marked for the 3 most populous jurisdictions: New South Wales, Victoria and Queensland. The reasons for this pattern are not clear and may relate to differences in hospital admission procedures or recordkeeping and coding practices between jurisdictions.

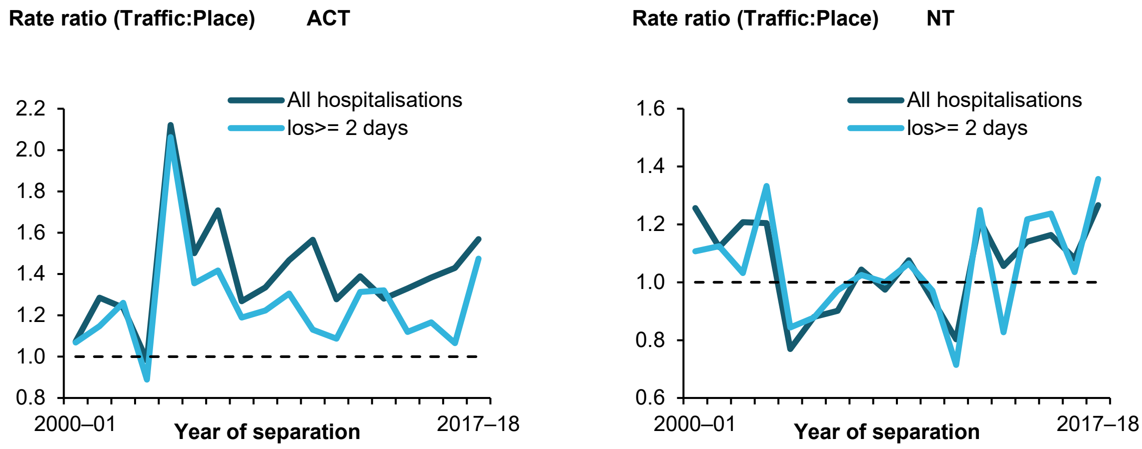
In most NISU reports, information on state and territory are usually reported in terms of the place of usual residence of the admitted person. Changes to hospital admission policies made by different jurisdictions at different time points can potentially affect counts and rates of hospital admissions for a particular jurisdiction. Taking this factor into consideration, it was decided that in would be more appropriate to report information on state and territory in terms of the location of the hospital to which the person was admitted rather than the person’s usual place of residence.

Figure 2.10: Pedal cyclist rate ratios by model, by state or territory of hospitalisation, by length of stay in hospital, 2000–01 to 2017–18



(continued)

Figure 2.10 (continued): Pedal cyclist rate ratios by model, by state or territory of hospitalisation, by length of stay in hospital, 2000–01 to 2017–18



Notes

1. Data underpinning this figure are available in the supplementary table spreadsheet Table S2.10.
2. Vertical scales across charts vary due to differences in ratios between jurisdictions.

Source: AIHW NHMD.

High threat to life and counterpart in collision

Analysis of rate ratios for the models by type of counterpart in collision found that omission of same-day cases had little impact on the ratios for most counterparts in collision (cars, pickup trucks and vans, another pedal cycle and a fixed or stationary object). For non-collision crashes, rate ratios for all hospitalisations and those with a length of stay of 2 or more days were similar in the first half of the period, after which they were moderately higher for the all hospitalisations cases. There was a marked decrease in the rate ratio when 1-day stay cases were omitted where the counterpart in collision was categorised as *Other and Unspecified*. Interpretation is as given in the Counterpart in collision section above.

Omission of same-day cases had little impact on the ratios for high threat to life cases given that the restriction to high threat to life cases already had the effect of excluding a high proportion of short-stay cases (see Table 2.2).

3 Effect of hospital admission policies on trends over time

Jurisdictions sometimes make changes to hospital admission policies and practices which can affect the way in which presentations, including injuries due to pedal cycle crashes, to emergency departments are treated. Two changes are detailed below:

- In July 2012, the Victorian Hospital Admission Policy changed significantly so that episodes of care delivered entirely within a designated emergency department or urgent care centre could no longer be categorised as an admission regardless of the amount of time spent in the hospital. Previously, these types of episodes could be categorised as an admission if the length of time in the hospital was 4 hours or more. This has had the effect of reducing the number of injury admissions recorded.
- From 15 June 2017, emergency department-only episodes were no longer included as admitted patient records in New South Wales hospitals.

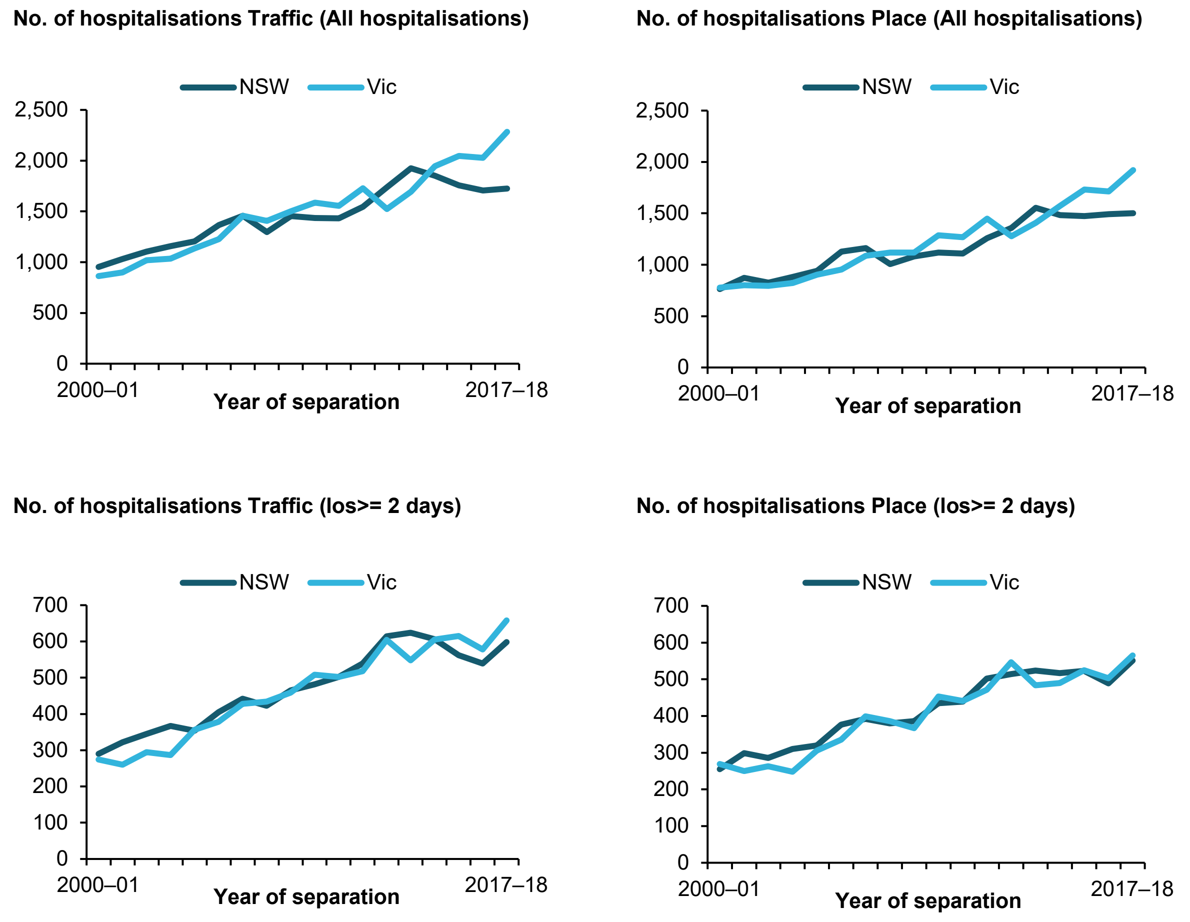
These administrative changes have had noteworthy effects on estimates of hospitalised injury (AIHW: Pointer S 2015; HealthStats NSW 2019). This section reports an assessment of their impact on hospitalised pedal cyclist cases.

Figure 3.1 shows the number of pedal cyclist hospitalisations for New South Wales and Victoria for the *Traffic* and *Place* models from 2000–01 to 2017–18 by length of stay.

For all cyclist hospitalisations, there was a drop in case numbers for Victoria between 2011–12 and 2012–13 for both the *Traffic* and *Place* models, coinciding with the admission policy change implemented from July 2012. When short-stay cases were excluded, case numbers for Victoria rose between 2011–12 and 2012–13 for both the *Traffic* and *Place* models.

For all cyclist hospitalisations, there was little change in case numbers in New South Wales for both the *Traffic* and *Place* models in the year after the admission policy change in June 2017. When short-stay cases were excluded, case numbers in New South Wales rose for both the *Traffic* and *Place* models. These patterns followed a period of 2 or 3 years in which numbers of hospitalised cyclist cases in New South Wales levelled or declined after a long period of rising case counts. The reason for this change is not known.

Figure 3.1: Pedal cyclist hospitalisations by model and length of stay in hospital, New South Wales and Victoria, 2000–01 to 2017–18



Notes

1. Data underpinning this figure are available in the supplementary table spreadsheet Table S3.1.
2. Vertical scales across charts vary due to marked differences in case numbers.

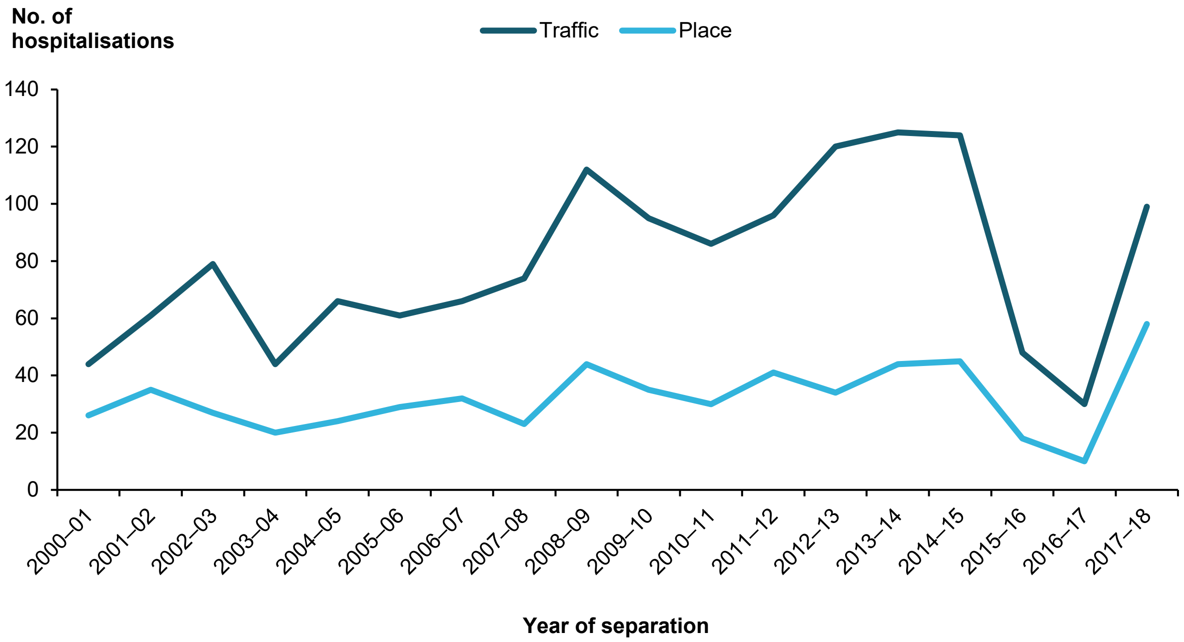
Source: AIHW NHMD.

External cause coding in New South Wales private hospitals

In the 2015–16 and 2016–17 hospital morbidity data sets for New South Wales, it was found that a significant number of injury cases admitted to private hospitals had not been assigned an external cause of injury code. For cases with a principal diagnosis in the ICD-10-AM range S00–T75, or T79 (community injury) which also had 'acute' as the type of care, 14,321 records of admissions to NSW private hospitals had not been assigned an external cause of injury code in the 2016–17 data and 14,776 records in the 2015–16 data. The number of such records dropped markedly, to 3,443, in the 2017–18 data.

Figure 3.2 shows the number cyclist hospitalisations for New South Wales private hospitals for the *Traffic* and *Place* models from 2000–01 to 2017–18. For both models, and particularly so for the *Traffic* model, there was a large drop in hospitalisations between 2014–15 and 2016–17 in line with the external cause coding issue. In 2017–18, when it appears that this coding issue had been largely addressed, there was a large jump in hospitalisations for both models.

Figure 3.2: Pedal cyclist hospitalisations by model, New South Wales private hospitals, 2000–01 to 2017–18



Note: Data underpinning this figure are available in the supplementary table spreadsheet Table S3.2.

4 Comparisons with criteria used for BITRE reports

The National Injury Surveillance Unit (NISU) has produced several reports and analyses for the Bureau of Infrastructure, Transport and Regional Economics (BITRE) on serious injury due to land transport accidents. These reports and analyses include information on hospitalisations due to pedal cycle crashes with a major focus on crashes that occured on road.

The criteria used to select hospitalisations due to on road pedal cycle crashes are very similar to the criteria used for the *Traffic* model used in this report, with 2 minor differences:

- Whereas the *Traffic* model includes only cases with a principal diagnosis in the ICD-10-AM code range S00–T75, T79, the BITRE criteria include cases with a principal diagnosis in the ICD-10-AM code range S00–T98 (that is, the BITRE criteria also include cases with a principal diagnosis of *Adverse effects, not elsewhere classified*; *Complications of surgical and medical care, not elsewhere classified; Other complications of trauma not elsewhere classified*; and *Sequelae of injuries, of poisoning and other consequences of external causes*).
- The *Traffic* model includes cases where the person died while in hospital, while the BITRE criteria exclude these deaths.

Table 4.1 compares the number of cyclist hospitalisations for the *Traffic* model and the BITRE criteria from 2000–01 to 2017–18. Overall, there were 219 more hospitalisations using the *Traffic* model over this period, an average of just over 12 additional hospitalisations annually. The inclusion of cases with a principal diagnosis in the ICD-10-AM range T78, T80–T98 made very little difference, resulting in an average of less than 1 extra hospitalisation annually.

In summary, excluding cases with a principal diagnosis in the ICD-10-AM range T78, T80–T98 would make no meaningful difference to any measured outcomes in terms of counts and rates for hospitalisations due to cyclist crashes occurring in an on-road setting.

Table 4.1: Pedal cyclist hospitalisations by *Traffic* model and BITRE criteria, Australia, 2000–01 to 2017–18

	Traffic			BITRE			
Data year	Discharged alive	Died in hospital	Total	PrDx = S00–T75, T79[(a)]	PrDx = T78, T80–T98[(b)]	Total	Difference: Traffic—BITRE
2000–01	3,049	10	3,059	3,049	1	3,050	9
2001–02	3,290	18	3,308	3,290	2	3,292	16
2002–03	3,592	11	3,603	3,592	1	3,593	10
2003–04	3,674	10	3,684	3,674	0	3,674	10
2004–05	4,037	14	4,051	4,037	1	4,038	13
2005–06	4,368	10	4,378	4,368	2	4,370	8
2006–07	4,792	11	4,803	4,792	1	4,793	10
2007–08	4,817	9	4,826	4,817	1	4,818	8
2008–09	5,264	20	5,284	5,264	1	5,265	19
2009–10	5,328	12	5,340	5,328	2	5,330	10
2010–11	5,167	11	5,178	5,167	1	5,168	10
2011–12	5,526	14	5,540	5,526	0	5,526	14
2012–13	5,909	11	5,920	5,909	3	5,912	8
2013–14	6,525	19	6,544	6,525	0	6,525	19
2014–15	6,710	15	6,725	6,710	0	6,710	15
2015–16	6,929	14	6,943	6,929	0	6,929	14
2016–17	6,861	11	6,872	6,861	1	6,862	10
2017–18	7,087	16	7,103	7,087	0	7,087	16
Total	**92,925**	**236**	**93,161**	**92,925**	**17**	**92,942**	**219**

(a) Principal diagnosis in the ICD-10-AM code ranges S00 to T75 or T79.

(b) Principal diagnosis in the ICD-10-AM code ranges T78 or T80 to T98.

5 Discussion and next steps

Assessment

The focus of the report is a comparison of counts and rates of hospitalised pedal cyclist injury cases according to 2 methods for estimating on-road cases. The first, labelled *Traffic* in this report, includes cases with ICD-10-AM *Traffic* codes, as described in Chapter 1. This follows the practice used in most previous reports of road injuries that are based on data coded according to the ICD-10-AM. The second, labelled *Place*, includes records where the place of occurrence was coded as '*Street and highway'*. Otherwise case inclusion follows the criteria usually used for AIHW reports (see Appendix A).

Note that the *Traffic* criteria as described above differ slightly from the criteria employed in AIHW reports of non-fatal land transport injuries that have been produced for BITRE. Chapter 4 provides a comparison of on-road cyclist case numbers when the *Traffic* method is used with the usual AIHW approach and the approach used in BITRE reports. The difference between the approaches is very small.

The *Traffic* and *Place* methods for estimating on-road cyclist cases on the basis of non-linked NHMD data gave similar estimates for older adults (Figure 2.2), cases with a specified counterpart in collision (Figure 2.4) and for cases that resulted in high threat to life injury (Figure 2.5) irrespective of age (Figure 2.6). Estimates were also similar for cases with hospital stays of longer than about 2 days (Figure 2.8).

The *Traffic* method gave substantially higher estimates of on-road cyclist cases than the *Place* method for cases involving children (Figure 2.2) and those with a poorly specified counterpart in collision (Figure 2.4). Estimates for cases with low threat to life or a short stay also tended to differ according to method.

The performance of the methods did not differ greatly between states and territories, except that differences appeared to be relatively small for cases involving NT residents, noting that relatively small case numbers and fluctuating rates constrained assessment (Figure 2.3).

The higher estimates based on the *Traffic* method than the *Place* method are likely to be largely due to the inclusion as *Traffic* cases of records that did not provide coders with specific information on the place of occurrence, leaving coders to rely on the ICD-10-AM defaulting rule.

The *Place* method should avoid counting such cases as occurring on-road and, in that respect, it can be expected to provide a better estimate than the *Traffic* method. However, the place-based method must be expected to omit some cases of hospitalised injury of cyclists that truly occurred on-road, namely cases in which information on place was not available, or not recorded.

Records with so little information about external cause that coders must rely on the defaulting rule when assigning an external cause code can be expected to commonly have place coded as 'unspecified'. Counterpart in collision is also commonly unspecified in these records. It is difficult to say how many of these probably poorly documented cases truly occurred on-road, but we must expect that some did.

Conclusions

Australian hospital morbidity data provide a good but imperfect basis for estimating and describing road injury, including cyclist cases. An ICD-10 (and ICD-10-AM) rule that requires use of *Traffic* codes where place of occurrence is not specified in the information available to the coder is problematic.

First, use of the rule can be expected to result in over-estimation of cases that are assigned as occurring 'in traffic'. This is particularly so for pedal cyclist cases because they commonly occur off-road. Cyclist cases might also tend to be less well documented than motor vehicle occupant cases. If *Traffic* codes are used as the basis for estimating road injury cases, then the results are likely to be overestimates.

Second, the impact of the ICD-10-AM defaulting rule may vary with the quality of the records available to coders. If hospital records describe cyclist cases very briefly (for example, 'bicycle accident', 'fell from pedal cycle'), without mention of place of occurrence then all or most will be coded as *Traffic*, irrespective of how many truly occurred on-road.

Third, nothing about a *Traffic* external cause code indicates whether it was assigned because of information in the record, or because of the ICD default-to-*Traffic* rule.

Place codes provide an alternative basis for estimating 'on-road' cyclist cases that includes fewer cases that truly did not occur on-road at the cost of probably omitting some cases that truly did occur on-road. Incompleteness of place coding and the lack of a way to identify which records were coded as *Traffic* on the basis of the defaulting rule leave a zone of uncertainty.

The report of Stage 1 of the linked crash data project designated as 'doubtful', in terms of 'on-road' status, land transport injury cases for which place was not *'Street and highway'* (Harrison et al. 2019). A similar approach should be applied for routine reporting based on non-linked hospital data, perhaps with refinements.

The work reported here is based on the coded statistical summaries of hospital records, rather than the hospital records themselves. Assessment of 1 or more samples of hospital records would enable assessment of how place of occurrence is represented in the documents on which coders must rely, and might enable assessment of the extent to which *Traffic* codes were based on use of the ICD-10 defaulting rule. The method developed and used by McKenzie and others (2009) would be suitable. Investigation of a sample of records could also enable assessment of the degree of alignment between the ICD-10 constructs *Traffic* and '*Street and highway'* as applied in Australian hospital morbidity data and the construct 'on-road' as applied by road safety agencies.

If it is accepted (or preferably confirmed on the basis of a study like that just mentioned) that records with a *Place* code of '*Street and highway*' truly occurred on-road, then those cases provide the foundation for a reliable lower estimate of hospitalised road injury cases.

Missing from that will be cases that truly occurred on-road but have missing place of occurrence or have certain specified *Place* codes other than '*Street and highway'*. It may be possible to use multivariate modelling with data from Stage 2 of the linked data study of road injuries to estimate how many of these cases occurred on-road. Linked crash data would be used as the benchmark for identifying a set of events that occurred on-road using a prediction model developed on the basis of a relevant set of hospital records.

In the longer term, consideration should be given to changing how road injury cases are coded in hospital data and to how the data used to make estimates are organised.
In particular:

- Reduce the present ambiguity between cases that are coded as *Traffic* on the basis of information that the crash did occur on-road, and those coded *Traffic* on the basis of the ICD-10 defaulting rule. This could be done by:
  - adding to ICD-10-AM a way to allow coders to distinguish between these 2 types of cases (for example, a flag to indicate that a *Traffic* code was assigned on the basis of the defaulting rule rather than specific information)
  - awaiting the introduction of ICD-11, which provides separate sets of codes for Unintentional transport injury events identified as: *road traffic*, *off-road (non-traffic)*, and *unknown whether road traffic or off-road (non-traffic)*.
- Revise relevant aspects of the ICD-10-AM place of occurrence classification:
  - Revise the inclusion/exclusion terms and sub-categories of the *'Street and highway'* place category to enhance alignment with the road safety construct 'on-road'.
  - Revise the inclusion terms and sub-categories of certain other place categories to make clearer for coders and data users whether they do, or might, include cases that occurred on-road, wholly or in part.
- When possible, base estimates on linked NHMD data:
  - Probabilistic linkage can be used to identify which records in the NHMD refer to the same person. Subject to the availability of certain other information and the use of an appropriate case estimation procedure, internally linked data allow better counting of cases that resulted in more than 1 episode of care in hospital.
  - Linkage can also be used to identify instances where a crash data record refers to the same person and injurious road crash that accounts for a hospital episode. This is the process that underlies the Stage 1 and Stage 2 Austroads projects.

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). Injury cases admitted to essentially all hospitals in Australia are included in the NHMD data reported here. Further information on the quality of NHMD data is provided in Appendix B.

Diagnoses and external causes of injury and poisoning were recorded using the International Statistical Classification of Diseases and Related Health Problems, 10th revision, Australian 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 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 and 10th editions, introduced in July 2015 and July 2017 respectively, were published by the Australian Consortium for Classification Development (ACCD 2015, 2017).

Selection criteria

Hospital separations

This report includes hospital separations that:

- occurred in Australia between 1 July 2000 and 30 June 2018
- 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.*

In addition to the above criteria, 4 models were used in this report:

- **Pedal cycle**—cases meeting the above criteria.
- **Traffic**—cases meeting the above criteria and where the first (that is, left-most) external cause code indicates that the injured person was a pedal cyclist (3-character codes V10–V19) who was injured in a traffic crash (V10–V18 with 4th character 4, 5 or 9 and V19 with 4th character 4, 5, 6 or 9), which can be abbreviated as V10–V18.[4,5,9], V19.[4,5,6,9].
- **Place**—cases meeting the above criteria and where any ICD-10-AM *Place of occurrence* code is Y92.4 *Street and highway*.
- **Traffic and place**—cases meeting the above criteria and where the first external cause code indicates that the injured person was a pedal cyclist (3-character codes V10–V19) who was injured in a traffic crash (V10–V18 with 4th character 4, 5 or 9 and V19 with 4th character 4, 5, 6 or 9), and where any ICD-10-AM *Place of occurrence* code is Y92.4 *Street and highway*.

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 number 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* (by about 60,000 records).

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 criteria but contain code Z50, Rehabilitation, reduces overestimation due to re-admissions.

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 and over 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 the oldest group of 85 and over.

Population denominators

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

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 for those seriously injured with high threat to life in a road vehicle traffic crash have previously been reported (AIHW: Henley & Harrison 2009; Henley & Harrison 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. 2003) and might allow more accurate comparisons between jurisdictions.

Appendix B: Data quality statement

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 patients, 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 patients in Australian hospitals. The scope of the NMDS is episodes of care for admitted patients 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 offshore territories are not in scope, but some are included.

The reference period for this data set is 2017–18. The data set includes records for admitted-patient separations between 1 July 2000 and 30 June 2018.

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

Summary of key issues

- The NHMD is a comprehensive data set that has records for all separations of admitted patients from essentially all public and private hospitals in Australia.
- A record is included for each separation, not for each patient, so patients who separated more than once in the year have more than 1 record in the NHMD.
- For 2017–18, almost all public hospitals provided data for the NHMD. The exception was an early parenting centre in the Australian Capital Territory. The great majority of private hospitals also provided data, the exception being the private free-standing day hospital facilities in the Australian Capital Territory.
- There is some variation between jurisdictions as to whether hospitals that predominantly provide public hospital services, but are privately owned and/or operated, are reported as public or private hospitals. In addition, hospitals may be re-categorised as public or private between or within years.
- Revised definitions for care types were implemented from 1 July 2013 with the aim of improving comparability in care-type assignment among jurisdictions. Therefore, information presented by care type may not be comparable with data presented for earlier periods.
- There was variation between states and territories in the reporting of separations for *Newborns* (without qualified days).
- Data on state of hospitalisation should be interpreted with caution because of cross-border flows of patients. This is particularly the case for the Australian Capital Territory. In 2017–18, about 17% of separations for Australian Capital Territory hospitals were for patients who resided in New South Wales.
    - Although there are national standards for data on hospital services, there are some variations in how hospital services are defined and counted, between public and private hospitals, among the states and territories, and over time. For example, there

is variation in admission practices for some services, such as chemotherapy and endoscopy; as a result, people receiving the same type of service may be counted as same-day admitted patients in some hospitals and as non-admitted patients in other hospitals. In addition, some services are provided by hospitals in some jurisdictions and by non-hospital health services in other jurisdictions. The national data on hospital care does not include care provided by non-hospital providers, such as community health centres.

- Caution should be used in comparing diagnosis, procedure and external-cause data over time, as the classifications and coding standards for those data can change over time.
- Between 2010–11 and 2017–18, there were changes in coverage or data supply for New South Wales, Victoria, Queensland and Western Australia that may affect the interpretation of the data:
- For New South Wales, increases in the numbers of separations reported for private hospitals are, in part, accounted for by improvement in the coverage of reporting.
- For Victoria, between 2011–12 and 2012–13, a relatively large decrease in public hospital separations reflects a change in Victoria's emergency department admission policy.
- For Queensland, from 2014–15, relatively large increases in same-day separations in public hospitals partly reflects changes in admission practices for chemotherapy at a small number of large establishments.
- For Western Australia, between 2012–13 and 2013–14, the relatively large decrease in public hospital separations may reflect a change in Western Australia's emergency department admission policy, which resulted in fewer admissions.

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Abbreviations

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AIHW	Australian Institute of Health and Welfare
BITRE	Bureau of Infrastructure, Transport and Regional Economics
ICD-10-AM	International Classification of Diseases, 10th revision, Australian modification
ICISS	ICD-based Injury Severity Score
los	length of stay
NISU	National Injury Surveillance Unit
NSW	New South Wales
NT	Northern Territory
QLD	Queensland
SA	South Australia
TAS	Tasmania
VIC	Victoria
WA	Western Australia

Symbols

>=	equals, or more than
<=	equals, or less than

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.

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.

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. The term includes acute care and psychiatric hospitals as well as private free-standing day hospital facilities.

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: The process by which an episode of care for an admitted patient ceases. A separation may be formal or statistical. A formal separation is the administrative process by which a hospital records the cessation of treatment and/or care and/or accommodation of a patient (see Mode of separation). A statistical separation is the administrative process by which a hospital records the cessation of an episode of care for a patient within the 1 hospital stay. In this report, cases have been selected for inclusion and grouped by year according to date of separation.

References

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: ACCD.

ACCD 2017. The International Statistical Classification of Diseases and Related Health Problems, 10th revision, Australian modification (ICD-10-AM). 10th edn. Sydney: ACCD.

AIHW (Australian Institute of Health and Welfare) 2017. Admitted patient care 2015–16: Australian hospital statistics. Health services series no. 75. Cat. no. HSE 185. Canberra: AIHW.

AIHW: Henley G and 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.

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

AIHW: Henley G & Harrison JE 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.

AIHW: Pointer S 2015. Trends in hospitalised injury, Australia: 1999–00 to 2012–13. Injury research and statistics series no. 95. Cat. no. INJCAT 171. Canberra: AIHW.

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

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.

Harrison JE, Watson A & Vallmuur K 2019. A national approach to measuring non-fatal crash outcomes. Sydney: Austroads.

HealthStats NSW 2019. Reporting of hospitalisation-related indicators on HealthStats NSW: Impact of changes to emergency department admissions. Sydney: HealthStats NSW Viewed 24 September 2020, <http://www.healthstats.nsw.gov.au/Resources/ED-admissions.pdf>

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.

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

McKenzie K, Enraght-Moony EL, Waller GS, Walker S, Harrison JE & McClure RJ 2009. Causes of injuries resulting in hospitalisation in Australia: assessing Coder Agreement on External Causes. Injury Prevention 2009 15(3):188–196.

NCCC (National Casemix and Classification Centre) 2013. The International Statistical Classification of Diseases and Related Health Problems, 10th revision, Australian modification (ICD-10-AM). 8th edition. Sydney: NCCC.

NCCH (National Centre for Classification in Health) 2000 to 2010. The International Statistical Classification of Diseases and Related Health Problems, 10th revision, Australian modification (ICD-10-AM). 2nd edn to 7th edn. Sydney: NCCH.

NCPS (National Cycling Participation Survey) 2020. Sydney: Austroads. Viewed 24 September 2020, <https://austroads.com.au/network-operations/active-travel/cycling-participation>.

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.

WHO (World Health Organization) 2016. International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10). Geneva: WHO.

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Related publications

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

AIHW: Kreisfeld R & Harrison JE 2019. Pedal cyclist deaths and hospitalisations, 1999–00 to 2015–16. Fact sheet.

This report compares the use of different criteria to distinguish between pedal cyclist hospitalised injury cases occurring in on-road and off-road settings. The *Traffic* method overestimates on-road cases because a coding rule requires that cases where place of occurrence is unspecified should be coded as occurring 'in traffic', while the *Place* method likely underestimates on-road cases because some cases with unspecified place of occurrence will have occurred on-road. Ways to improve delineation between on-road and off-road cases are proposed.

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