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Road crashes involving bike riders in Victoria, 2002–2012: an Amy Gillett Foundation report

By Megan Garratt, Marilyn Johnson and Jacinta Cubis

July 2015

Report Documentation Page

Title: Road crashes involving bike riders in Victoria, 2002–2012

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Date: July 2015

ISBN number: 978-0-646-94080-9

Report status: Final, Corrected version, September 2015

Sponsoring Organisation(s):

This project was funded by a Community Road Safety Grant received from the Transport Accident Commission (TAC). The study was conducted and this final report was written by the named authors for the Amy Gillett Foundation. Revisions were made by staff at the TAC and have been incorporated into this document. This report is published with approval from the TAC.

Keywords: bike rider crashes, fatality, serious injury, Victoria

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1 Executive Summary

There are many benefits to bicycle riding and an increasing number of people in Victoria are choosing to travel by bike to work, for sport and for fun. However, the number of bike rider crashes is also increasing.

This study is a multi-year analysis of bicycle rider crash statistics undertaken using Victorian CrashStats. It clearly shows that there are distinct differences in the crash profiles of fatal bike rider crashes compared to non-fatal crashes. Across all bike rider crashes, the highest proportion occurred in urban areas, mainly metropolitan Melbourne. However, almost half of all bike rider fatality crashes in Victoria occurred in regional areas. Rear-end crashes with the vehicles travelling in the same direction were the crash type which resulted in the greatest proportion of bike rider fatality crashes. Of all bike rider crashes, more were likely to occur at intersections and heavy vehicles were involved in over a third of fatality crashes. While it is important to take action to improve the safety of the circumstances that result in fatality crashes, it is also important to recognise the enormous and increasing number of people who are injured in non-fatal crashes. Given the differences in bike rider crash profiles, countermeasures that reduce fatal crashes may not achieve similar crash reductions in non-fatal crash types. These differences need to be taken into account when considering investment in action to improve bike rider safety.

Bike rider crash analysis is an important component to understanding how to create a safe cycling environment. However, the insight offered by crash data analysis alone is limited and comprehensive data about cycling trip, or exposure data, is required to understand how changes in participation affect crash rates. Further, it is important to acknowledge that while police data provides one of the most comprehensive data sources about road user crashes, there are limitations that need to be considered.

Bike riders are vulnerable road users who, like motorbike riders, often share the road with motor vehicles. In the discussion of the findings, some of the contributing factors to the crash types are identified and solutions to address such factors are highlighted. This discussion of the findings in this report aims to improve the safety of all bike riders in Victoria, and most of the findings are likely to be applicable to bike riders in other Australian states and territories. The findings could also contribute to a safe road environment for motorbike riders, as many of the same issues affect the safety of all two-wheeled vehicles.

Note: It is important to note that this report contains **analysis of crashes reported to Victoria Police**. While Victorian law requires that injury road crashes must be reported to police, research shows that not all bike rider crashes are reported to police. Reasons for non-reporting include: little or no property damage; perception of wasting scarce police resources; fear that a report may result in prosecution; crashes where the bike rider is the only injured party; misconception that crashes involving bike riders are not road traffic crashes; and misclassification of injury severity.

As a result, police-reported crashes are highly likely to involve a motor vehicle, often considered the trigger for reporting the crash to police. This trigger for reporting crashes to police is an important context when analysing bike rider crashes in this dataset.

1.1 Summary of police-reported bike rider crashes

- Period analysed: 1 January 2002 to 31 December 2012
- Bike rider crashes have increased annually since 2003 (police and hospital reported crashes)
- Total number of bike rider crashes: 14,270 100%
    - Fatality 86 0.6%
    - Serious injury 4582 32.1%
    - Other injury 9602 67.3%

Bike rider crashes – all

- Gender: 77% male
- Age: 85% adult
- Location: 81% metropolitan Melbourne
- Crash type: 23% vehicles from same direction
- Geometry: 60% at intersections
- Motor vehicle: 90% involved a motor vehicle – 4.3% involved a heavy vehicle
- Speed zone: 77% in 50kph or 60kph zones
- Helmet: 75% yes
- 9% of all non-fatal crashes were the result of a driver or passenger opening a vehicle door

Fatal bike rider crashes

- Gender: 82% male
- Age: 49% aged 30-59 years
- Location: 52% metropolitan Melbourne, 48% regional Victoria
- Crash type: 49% vehicles from same direction (including 26% rear end)
- Geometry: 65% **not** at intersections (e.g. mid-block)
- Motor vehicle: 87% involved a motor vehicle – 35% involved a heavy vehicle
- Speed zone: 36% in 50kph or 60kph zones – 59% in speed zones of 70kph or higher

Serious injury bike rider crashes

- Gender: 78% male
- Age: 48% aged 18-39 years
- Location: 80% metropolitan Melbourne
- Crash type: 20% vehicles from the same direction
- Geometry: 58% at intersections
- Motor vehicle: 86% involved a motor vehicle – 6% involved a heavy vehicle
- Speed zone: 75% in 50kph or 60kph zones

Other injury bike rider crashes

- Gender: 76% male
- Age: 50% aged 30-59 years
- Location: 82% metropolitan Melbourne
- Crash type: 23% vehicles from the same direction
- Geometry: 61% at intersections
- Motor vehicle: 91% involved a motor vehicle – 3% involved a heavy vehicle
- Speed zone: 78% in 50kph or 60kph zones

- While police-reported crashes provide the most comprehensive publicly available data, these data must be used with caution, as:
  - not all crash types are reported to police (e.g. crashes that did not involve a motor vehicle)
  - bicycle rider crashes are less likely to be reported to police
  - police reports do not include all crash types (e.g. bicycle rider-only crashes).
- 2.41 times more bike rider crashes were reported to hospital compared to all police-reported bike rider crashes.
- A category that clearly differentiates electric bikes needs to be added to the reported bike rider crash data. Electric bike uptake is rapidly increasing and Australian research shows their crash profiles differ compared to those of pedal bicycles. Electric bikes need to be clearly identified in the crash data to ensure accurate monitoring compared to pedal bikes over time.

2 Introduction

Each week in Victoria, 1.08 million people ride their bikes (Victorian Government 2012). However, bike riders have a significantly higher crash risk compared to vehicle occupants. Research shows that when bike riders and drivers travel the same distance, bike riders have a fatality risk 4.5 times that of vehicle occupants and the relative risk of injury is 13 (police data) or 34 (hospital data) compared to driving (Garrard et al. 2010).

This study has been undertaken with support from the TAC Community Road Safety Grant (Round 11) with funding awarded for the Road Right – Drive Rules Program project application to provide an update of bicycle rider crashes in Victoria from 2002 to 2012. The purpose of the study is to improve our understanding of the characteristics of the bicycle rider crashes that were reported to police over that period. The study includes a Background which provides an overview of cycling in Victoria including participation and crashes, followed by the Study Design, Results and Discussion.

The publicly available CrashStats database of road trauma crashes was analysed for crashes involving bike riders. The following analyses were conducted:

- Overview of bike rider crashes
- Characteristics of bike riders who crashed, including analysis by injury outcome
- Characteristics of bike rider crashes, including crash type, motor vehicle involvement
- Mapping crashes: identifying locations with high volume of bicycle rider fatality crashes

2.1 Background and context

Bicycle riders are one of the most physically vulnerable road user groups that travel on our roads. They are recognised by law as legitimate road users, but the space for bike riders on Victorian roads varies from fully separated (e.g. fully separated cycle lanes in Melbourne) to symbolically or notionally separated (e.g. bike lanes, wide kerbside lanes) to completely intermingled travel with motorised vehicles, ideally in slow-speed streets (Levasseur 2014). Australia's cycling environment contrasts with extensive networks of physically separated facilities for cycling that exist in European countries with high cycling participation (Pucher et al. 2010). In Australia, the interaction with vehicles on the road contributes to a higher rate of bike rider fatality and serious injury crashes compared to Europe (Garrard et al. 2010).

2.2 Cycling participation in Victoria

In Victoria, an increasing number of people are riding their bike for transport and recreation. The Victorian Government's Cycling Strategy (Victorian Government 2012) reported strong growth in cycling from 2001 to 2011, with 1.08 million Victorians riding a bike each week and, among commuters, that increase was 5 per cent each year.

At a public policy level, there is widespread support for cycling. State and local governments consistently promote cycling as a viable active transport option, acknowledging that a small increase in active transport can lead to positive outcomes for the transport system. These outcomes include increased capacity, reduced vehicle congestion and environmental impacts, improved public health and reduced healthcare costs, and improved community wellbeing and social cohesion (Victorian Government 2012).

The intentions of the state government bode well for bike riders and bike rider safety (Victorian State Government 2013), with short-term goals of speed reduction to 40kph in areas with high volumes of bike riders, greater separated crossings at major roads, working with local councils to develop strategic cycling corridors and a focus on creating '20 minute neighbourhoods' with every suburb within a short commute to everyday services and jobs.

The Victorian Government, along with many Victorian regional and metropolitan local governments, has incorporated bike riding into its transportation and sustainability strategies. Regional centres such as Geelong, Ballarat, Bendigo, Wodonga, Shepparton and Horsham have included plans to increase regional bike riding facilities, improve cycling safety and incorporate bike networks in town planning (Hennessy Services 2007, Ratio Consultants 2007, City of Greater Geelong 2008, Victorian State Government 2013, Greater Shepparton City Council 2014).

Cycling-inclusive public policies are an important and positive step to creating a safer cycling environment; however, in Victoria, while we wait for these aims to be realised, there has been a concurrent increase in the number of bike rider crashes.

2.3 Literature review of Victorian bicycle rider crashes

The scientific literature has been reviewed for recent publications (2010 to 2014) that analysed bicycle rider crashes in Victoria and are discussed below.

Garrard and colleagues (2010) compared risk of injury outcomes crashes between bike riders and vehicle occupants (drivers and passengers) in metropolitan Melbourne. When bike riders and drivers travelled the same distance, bike riders had a fatality risk 4.5 times that of vehicle occupants and the relative risk of injury was 13 (police data) or 34 (hospital data) compared to driving. While the authors caution the use of fatality figures due to the low and highly variable number, they concluded that the car-centric nature of many road safety measures in Australia means they have done little to improve bike rider safety.

Andrew and colleagues (2012) reviewed sports and recreation trauma in Victoria from 2001 to 2007. They reported that cycling-related trauma increased by 16 per cent per year. Of note were crashes with motor vehicles travelling at speeds greater than 24kph (>15mph). The authors reported that it is difficult to determine the extent to which increased cycling participation has contributed to the increase in cycling related trauma, a data limitation that has been repeatedly identified in the literature (Sikic et al. 2009, Garrard et al. 2010).

> 'SmartRoads focuses on the most efficient ways to move people and goods, rather than vehicles. It promotes safety outcomes by being particularly responsive to pedestrian activity and separation for cyclists, and it has an inbuilt bias towards sustainable modes, recognising that they have the greatest potential to accommodate future growth in demand, as well as the improved amenity and environmental outcomes they deliver.'
>
> Plan Melbourne, May 2014, p87

A review of police-reported crashes in Victoria between 2004 and 2008 by Boufous and colleagues (2012) identified the following risk factors that increased the risk of severe injury in bike rider–motor vehicle crashes:

- Age – riders aged 50 years or older were twice as likely to be severely injured as younger bike riders
- Not wearing a helmet – 56% increased risk of severe injury
- Speed limits – risk increased proportionally with road speed limits
- Riding at night – especially in areas that were unlit or had poor lighting
- Curved sections of road – 86% increased risk compared to straight roads
- Crashes in rural Victoria had a higher risk of severe injury (and fatality) because of higher

speeds in rural areas, involvement of alcohol, lack of cycling infrastructure and delays of medical care post-crash.

Boufous and colleagues (2013) analysed police and hospital bike rider crash data for the same period to compare single- versus multiple-vehicle bike rider crashes in Victoria. The total reported number of crashes reveals a significant disparity, with twice the number of bike rider crashes reported in hospitals records (n=6432) compared to police (n=3937) bike rider crashes. Of the crash types, multiple-vehicle crashes were the majority of police-reported crashes (95.1%), yet multiple-vehicle crashes were less than half (45.1%) of hospital records. The authors conclude that police reports include valuable crash data; however, single-vehicle crashes are significantly underreported. Yet, while hospital records better capture incident prevalence, there is a lack of crash-related data. Of the single-vehicle crashes, the bike riders' loss of control was reported as the main cause of the crash (82.6% police; 86.7% hospital). However, as the authors noted, these data may be affected by subjective opinion at the time of the crash, rather than extensive investigation. Further, it is possible that a single vehicle crash is the result of a bike rider losing control after taking evasive action to avoid a crash with a vehicle but this is not reported.

Recognising the limitations of the two data sources (police and hospital), Biegler and colleagues (2012) conducted an in-depth crash investigation with 158 bike riders who had crashed and presented to either the Sandringham or Alfred hospitals in Melbourne. Major findings related to bike rider crashes included:

- Majority of bike riders who crashed were regular bike riders; 81% cycled 2–3 times per week, including 62% who cycled more than 3 times per week
- 93% of riders wore a helmet, of whom 45% sustained helmet damage due to a head strike during the crash
- Crash type: 39% multiple-vehicle; 60% single vehicle
- Loss of control was the main cause of single-vehicle crashes, coded from the rider's description of the crash
- Factors affecting the risk of a head injury:
    - Bike rider speed before the crash; estimated odds of sustaining a head injury compared to a bike rider travelling below 20kph:
        - 20–29kph: 2.7 times the risk of head injury
        - 30kph and over: 4.9 times the risk of head injury
    - Helmet use: 1.8 times higher risk of head injury if not wearing a helmet compared to wearing a helmet.

In their analysis of police and hospital reported data, Boufous and colleagues (2013) reported that loss of control was the main cause of bike rider crashes, particularly in single-vehicle crashes (police 82.6%; hospital 86.7%). However, there is little causal data available to determine the contributing factors in a crash, especially in the hospital-reported data. Indeed, in their study involving in-depth interviews with bike riders who had crashed, Biegler and colleagues (2012) reported that loss of control was the main contributing factor in only seven of the total of all crashes (4.4%). In more detailed analysis of crash events, there is a preceding event that causes the loss of control: four riders lost their balance (e.g. while attempting to throw a banana peel onto the roadside, travelling over a speed hump), one rider's shoe slipped in the rain, one rider's sunglasses fell off causing sudden braking and loss of control, and one rider lost control when the exercise mat they were carrying was caught in the wheel.

It is important to deconstruct the events preceding a crash to fully understand the factors that contribute to the crash event. 'Loss of control' is a vague and overarching classification that does not offer meaningful insight into the factors that contributed to the crash and cannot be effectively used to develop countermeasures to improve bike rider safety.

A review of Transport Accident Commission (TAC) claim data provides additional crash type context. Ruseckaite and colleagues (2012) reviewed a total of 204,315 adult claims for injury and death compensation made to the TAC from 1995 to 2008, of which road user type was available for 199,002. The authors' focus was on healthcare following transport injury for all road user types and they reported that bike riders were 3.5 per cent of all analysed adult claims where road user type was available (n=7004). Of the bike rider claims, the majority (61.5%) were for transport injuries that did not require hospitalisation, with 38.5 per cent resulting in hospital admissions (38.5%). This proportion of non-hospitalised compared to hospital admissions was comparable to the claims made by drivers (67.8%) and passengers (65.5%), but was higher than the proportions reported for motorcycle riders (42.2%) and pedestrians (44.9%).

Of note is a recent collaborative study by researchers from Victoria and the Netherlands that analysed trauma outcomes for bike rider crashes in Victoria and the south-west Netherlands (Yilmaz et al. 2013). They reported that head injury is a leading cause of death and long-term disability from bicycle crash injuries and it may be prevented by wearing a helmet. Bike riders who presented to hospital in the Netherlands suffered from more serious head injuries than patients in Victoria. The authors concluded that there was a higher mortality rate associated with a higher percentage of serious head injuries in the Netherlands compared to Victoria and that the head injuries may have been preventable with the use of a bicycle helmet (Yilmaz et al. 2013).

Recent reviews of bike rider crashes have provided insight into the types of crashes that occur. The reviews also highlight the gaps in the data that are available and the limitations in using police and hospital data to understand bike rider trauma crashes. Despite these limitations, it is important to maintain regular reviews of the data to monitor changes over time and to investigate those factors that are reported. Such evidence is essential to informing action to improve safety for all bike riders.

3 Study Design

The purpose of this study is to increase our understanding of police-reported bike rider crashes for the period 1 January 2002 to 31 December 2012 using the publicly available internet edition of CrashStats, the Victorian crash statistics and mapping program delivered by the state road authority, VicRoads. Data were not available for the entire year for 2013; therefore, this report includes data up until 31 December 2012, the most recent full-year data that were available at the time of preparing this report.

The following analyses were conducted:

- Overview of bike rider crashes
- Characteristics of bike riders who had crashed, including analysis by injury outcome
- Characteristics of bike rider crashes, including crash type, motor vehicle involvement
- Mapping crashes: identifying locations with high volumes of bicycle rider crashes.

To provide context for the changes in bike rider crashes in Victoria, a brief overview of data from 1 January 1987 is also included. All figures included in the main body of the report are those generated by the query “Location is Region(s): TOTAL VICTORIA; Road User Type is Bicyclist; Date range is 01/01/2002 to 31/12/2012”.

3.1 Definitions

3.1.1 Injury outcome

Definitions for injury outcomes used in this report were taken from the VicRoads CrashStats User Guide (VicRoads 2008) and are as below:

Fatality injury: killed or died within 30 days of the crash

Serious injury: sent to hospital, possibly admitted

Other injury: typically required medical treatment (e.g. bruising, pain, soreness)

3.1.2 Locations

In this report, location data is presented in two classifications. The first is a distinction between metropolitan Melbourne and regional Victoria. The CrashStats data categorise Victoria into nine categories from Melbourne CAD (Central Activity District) to Rural (VicRoads 2008). The list below shows how these VicRoads location descriptors were classified in this study.

Location	Study classification
Melbourne CAD	Metro Melbourne
Urban Melbourne excluding CAD e.g. suburbs	Metro Melbourne
Other Urban Areas in MSD <Melbourne Statistical Divisions) e.g. small outlying towns	Metro Melbourne
Large provincial cities	Regional Victoria
Small provincial cities	Regional Victoria
Other cities/towns	Regional Victoria
Small towns	Regional Victoria
Hamlets	Regional Victoria
Rural i.e. ‘open road’	Regional Victoria

Second, municipal or local government areas were also used in the analysis of crash trends over the period (2002–2012). In total, there are 79 separate municipalities in Victoria and 7 unincorporated areas. The maps below show the metropolitan Melbourne and regional Victorian municipalities.

Figure 1 Map of metropolitan Melbourne Local Government Areas (LGAs)
Source: File:Australia Victoria location map.svg

Figure 2 Map of Victorian (non-metro) Local Government Areas (LGAs)
Source: File: Australia Victoria location map.svg

3.1.3 Definitions for Classifying Accidents (DCAs)

All crashes reported to police in Victoria are coded using the Definitions for Classifying Accidents or DCA codes, which are included in the CrashStats database. In these codes, vehicles in a crash, up to two vehicles, are positioned relative to each other, then travel direction and point of conflict are identified. Crashes are coded under ten classifications:

- Pedestrian on foot, in toy/pram
- Vehicles from adjacent directions (intersections only)
- Vehicles from opposing direction
- Vehicles from same direction
- Manoeuvring
- Overtaking
- On path
- Off path on straight
- Off path on curve
- Passenger and miscellaneous

Each category consists of up to nine scenarios that depict the movements of the road users immediately preceding the crash. Bicycle rider crashes have been analysed by DCA code in this report. A full list of DCA codes and their illustrative diagrams is included as an appendix.

3.2 Limitations

There are two major limitations to using police-reported data to understand how crashes involving bike riders occurred. The first limitation is the CrashStats dataset itself and the second is that not all cycling-related crashes are reported to police. While many bicycle rider crashes may not require reporting to police (e.g. a child falls on a footpath), there is also a gap in reporting of serious bicycle rider crashes to police (Sikic et al. 2009). A report by Victoria Police suggested that as few as 1 in 30 bicycle rider crashes are reported to police (Harman 2007).

3.2.1 CrashStats data

CrashStats is a repository of police reports from traffic crashes that have been logged in Victoria since 1987. Over this time there have been changes made to the reporting methods and technology used to manage the data, and for this reason a number of limitations exist and have been identified by VicRoads (2008):

- In 1989 there was a change to injury classification and definitions
- In 1990 a change was made to the collection of road surface type data; prior to this time, only one road surface type was recorded, but since 1990 the road surface type for each vehicle involved the crash has been recorded
- Real times of crashes are rarely known and it is common for police to round to the nearest five-minute interval or hour when estimating the time of a crash
- There are occasional discrepancies in the number of reported persons in crash events depending on the type of query run through CrashStats; this is significant in the Age/Sex Summary queries
- In 2005 the method of recording crash information was changed from a paper-based form to electronic coding; this particularly affects data relating to non-fatal crashes

3.2.2 Gaps in reporting of crashes

It is widely recognised that not all bike rider crashes are reported, both in Australia and internationally, and this is a significant limitation of many cycling studies (Agran et al. 1990, Harris 1990, Schlep and Ekman 1990, Ameratunga et al. 2006, Veisten et al. 2007, Sikic et al. 2009). Unlike bike rider fatality crashes, there is no legal requirement to report non-fatal bike rider crashes to police, especially if there is no property (vehicle) damage, despite some crashes resulting in serious injuries to cyclists. As a result of this lack of reporting, analysis of bicycle rider crashes using solely police data is likely to underrepresent the magnitude of cycling crashes. In a report by Victoria Police, Harman conservatively estimated that only 1 in 30 non-fatal bike rider crashes is reported (Harman 2007). Further, studies that examined police and hospital reported crashes for all road users show that not all non-fatal injuries are reported to police. A study of underreporting of NZ road trauma reported that less than two thirds of all hospitalised road crash victims were reported to police (Alsop and Langley 2001).

Researchers have cautioned against using official crash records to quantify or investigate bike rider crashes, due to the extensive underreporting (Bull 1975, Lindqvist 1991, Welander et al. 1999, Stone and Broughton 2003, de Lapparent 2005, Gavin et al. 2005, Lujic et al. 2008, Sikic et al. 2009). With this caution in mind, in this study we obtained the numbers of hospital-reported bike rider crashes to determine the level of difference. We also recognised that there are likely to be a high number of injury crashes that are also not reported to hospital: riders may not seek medical attention or may be treated by other healthcare professionals who do not need to report these crashes centrally.

It is important to note that the criterion for a crash to be reported on CrashStats is that the police recorded the event, either at the scene or post-event with a physical report at a police station. Typically this means that there has been physical or property damage in the crash (i.e. usually motor vehicle damage) that requires formal reporting, often as part of the insurance cost-recovery process. This is an important distinction, as this 'vehicle damage' trigger is likely to lead to a greater proportion of vehicle-involved crashes being reported and is likely to overrepresent the proportion of vehicle-involved cycling crashes. This is particularly important in bike rider crashes, as a crash with minor/no property damage may still result in serious personal injury.

3.3 Hospital data

Given that not all bike rider crashes are reported to police, hospital data on bike rider crashes in Victoria for the same period was obtained from the Victorian Injury Surveillance Unit (VISU) to provide a broader context for bike rider crashes. These data were extracted from the Victorian Admitted Episodes Dataset (VAED) and the Victorian Emergency Minimum Dataset (VEMD). The VAED is collected from all Victorian public and private acute hospitals including rehabilitation centres, extended-care facilities and day-procedure centres. The VEMD is collected from 39 Victorian hospital emergency departments. The data presented below are a summary of both the VAED (admitted to hospital) and the VEMD (non-admissions) datasets.

In Victoria, over the period from 2002 to 2012, a total of 34,417 bike rider crashes were reported in the hospital datasets, compared to 14,270 reported to police. However, it is important to clarify that the majority of all police-reported crashes occurred on-road (97%) whereas of the bike riders who presented to hospital, the majority were in a traffic environment (i.e. public road space) (61.7%) and almost a third (38.3%) occurred in a non-traffic environment.

In total, over the period from 2002 to 2012, 2.41 times more bike rider crashes were reported to hospital compared to all police-reported bike rider crashes. Table 1 shows the number of police-reported and hospital reported bike rider crashes. Figure 3 shows the number of police-reported bike rider crashes compared to hospital-reported crashes for both traffic related crashes and all bike rider crashes by year from 2002 to 2012.

Table 1 All police and hospital (in-traffic) reported bike rider crashes in Victoria, 2002-2012

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Police	1,144	1,034	1,204	1,256	1,210	1,272	1,338	1,441	1,449	1,527	1,395	14,270
Hospital	2,372	2,579	3,046	3,316	3,528	3,766	3,544	3,511	3,149	2,858	2,748	34,417

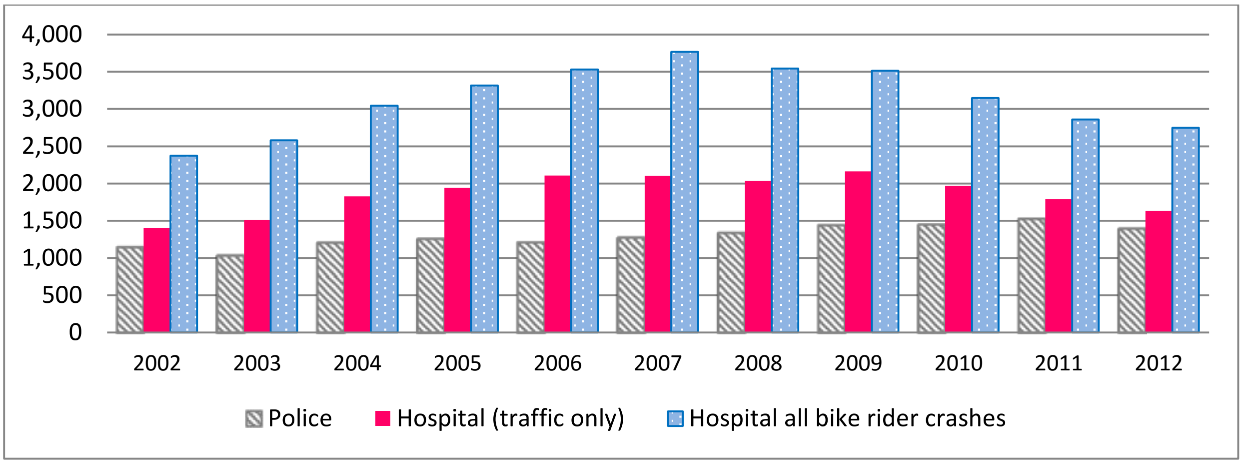


Figure 3 All police and hospital (traffic and all bike rider crashes) reported bike rider crashes in Victoria, 2002-2012

3.3.1 Bike rider crashes as a proportion of all road crashes

Nationally in Australia, bike rider crashes account for 18 per cent of all serious injury land transport crashes (Henley and Harrison 2009). Given the difference between police and hospital reported bike rider crashes in Victoria, the percentages of all bike rider crashes as a proportion of all road crashes were calculated for each dataset.

The annual number of reported crashes for each road user group was calculated using the denominator for that dataset. That is, the numbers of police-reported bike rider crashes were standardised using total numbers of police-reported crashes for all road users and the numbers of hospital-reported bike rider crashes were standardised using the total numbers of hospital-reported crashes for all road users.

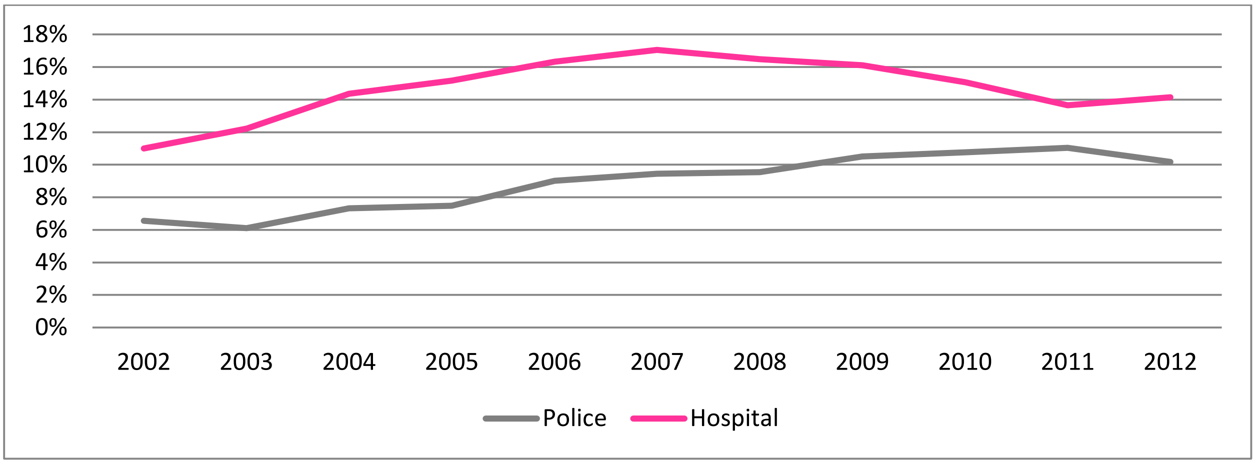


Figure 4 Percentage of all bike rider crashes as a proportion of all road crashes in Victoria, 2002-2012

Across the 11-year period, as a proportion of all road crashes, the number of police-reported bike rider crashes averaged 8.9 per cent, whereas hospital-reported bike rider crashes comprised 14.7 per cent of all road crashes. The hospital data are comparable to the nationally reported data that bike riders comprise 18 per cent of all road trauma crashes.

On average, bike rider crashes account for:

- *8.9% (police data)*
- *14.7% (hospital data) of all road crashes in Victoria (2002–2012)*

Clearly, identifying that fewer bike rider serious injury and minor injury crashes are reported to police compared to those recorded in hospital data provides important context.

However, hospital data do not provide any data on the crash circumstances and therefore cannot be used to understand how crashes occurred, and more importantly, identify action that may prevent future crashes. Despite its limitations, CrashStats provides the singular most comprehensive data source of road user crashes. No other publicly available and routinely published data provide the same level of detail about crash circumstances.

4 Results

Results are presented in three sections:

1. An overview of all bike rider crashes from the CrashStats database (1987–2012)
2. Analysis of all bike rider crashes from 2002–2012
3. Area analysis of bike rider crashes, including mapped crashes

4.1 Overview of police-reported crashes

Figure 5 is a graph of all police-reported bicycle rider crashes from 1987 to 2012. This graph is included to provide context for the changes in bike rider crashes (fatality, serious injury, other injury) over that period. The primary Y axis (columns) shows the total number of bike rider crashes, including fatality, serious injury and other injury crashes. The line on the secondary Y axis (line) shows bike rider crashes as a proportion of all road crashes.

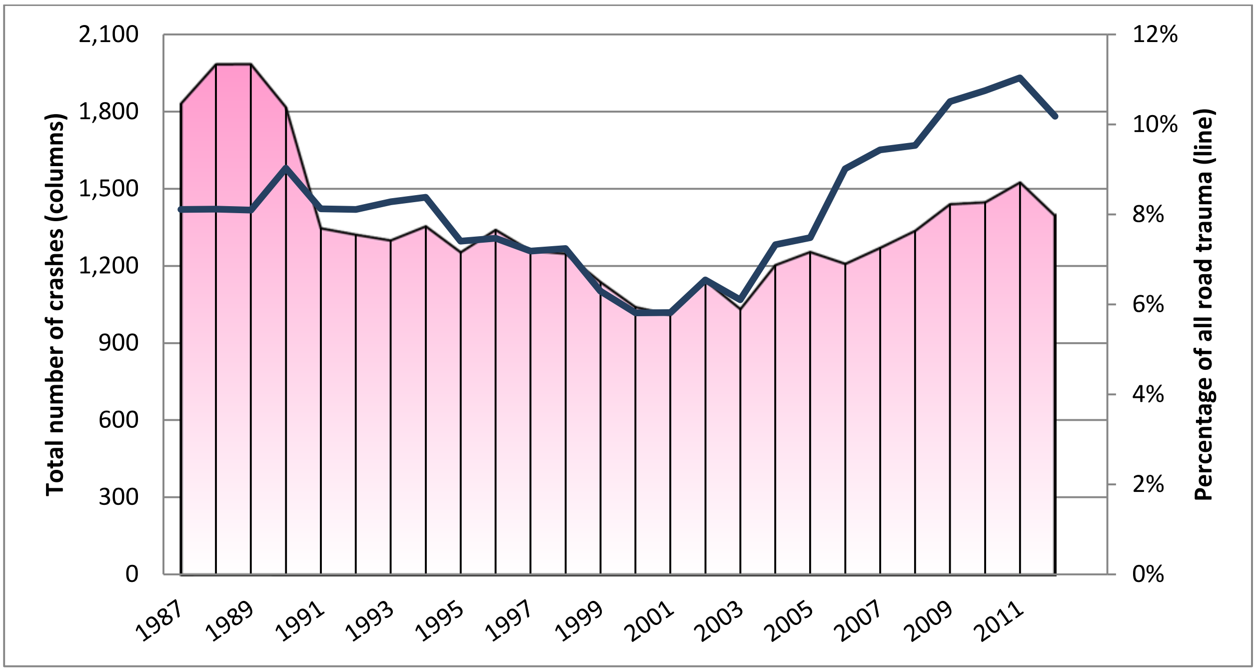


Figure 5 All bike rider crashes (fatalities, serious injuries and other injuries) in Victoria: total number of reported events and percentage of total road toll, 1987-2012

Over the past 25 years, 35,515 bike riders have been involved in crashes, equating to over 1,000 riders every year. Since 2002, the proportion that bike rider crashes account for in the total road toll has increased from a low of 5.8% (2001) to 11.0% (2011).

Figure 6 presents all crashes by injury severity for all bicycle rider road trauma crashes over the 25 year period from 1987 to 2012. The majority of all crashes were other injury crashes (68.8%), with almost a third of crashes resulting in serious injuries (30.4%) and 1 percent of police reported bicycle rider crashes were fatalities (0.9%; n: 314).

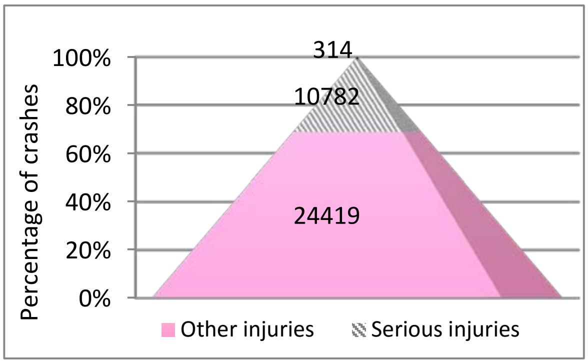


Figure 6 All bike rider crashes in Victoria by injury outcome, 1987-2012

The focus of this report is the period from 2002 to 2012. The remainder of the results included in this report is for this period.

4.2 Analysis of police reported bike rider crashes (2002–2012)

4.2.1 Injury outcomes

From 2002 to 2012, 14,270 bicycle riders were involved in road trauma crashes. While the broader historical context shows that the total number of bicycle rider road trauma crashes has decreased since the late 1980s, there has been a steady annual increase in both the number of bike rider crashes and the proportion of all road trauma crashes (Figure 7) since 2003 (1034 crashes).

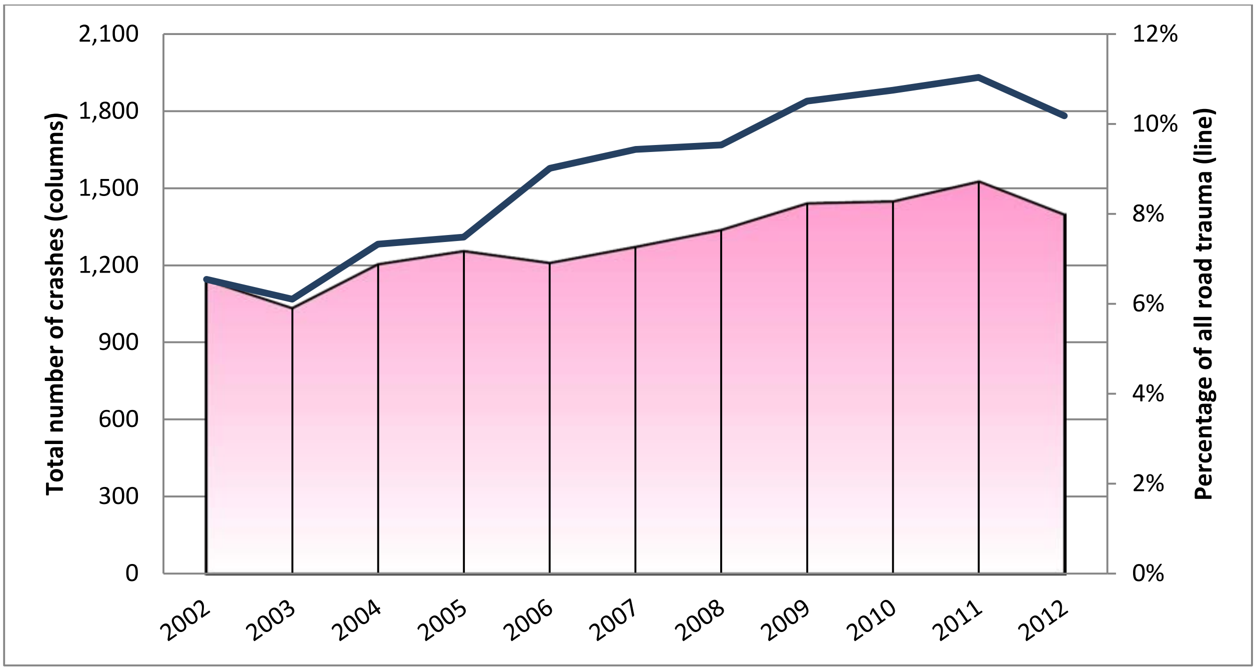


Figure 7 All bike rider crashes (fatalities, serious injuries and other injuries) in Victoria: total number of reported events and percentage of total road toll, 2002-2012

The charts below show the annual number of bike rider crashes by injury outcome for the period 2002-2012. The serious injury category includes people whose crash resulted in an outcome of total and permanent disability.

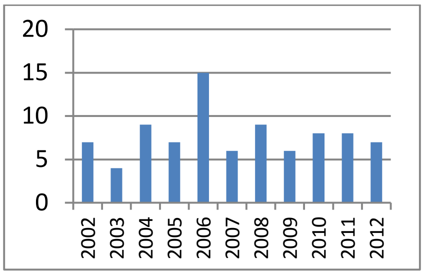


Figure 8 All fatal bike rider crashes in Victoria, 2002-2012

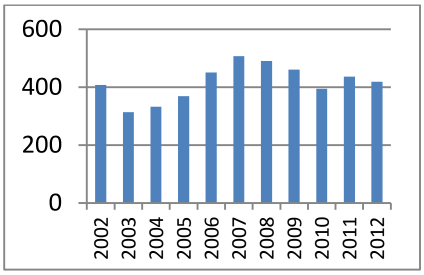


Figure 9 All serious injury bike rider crashes in Victoria, 2002-2012

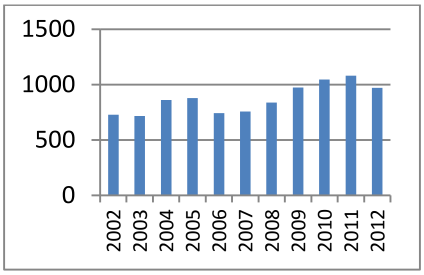


Figure 10 All other injury bike rider crashes in Victoria, 2002-2012

4.2.2 Bicycle rider characteristics

Gender

More males were involved in bicycle rider crashes than females (Figure 11). While there is a perception of higher risk-taking behaviour among males than females, this cannot be determined from these data. The overrepresentation of males may be a function of exposure, as a larger proportion of the known cycling population in Victoria, and Australia, is male (in Victoria, rode in past 7 days: males: 20.9%, females: 12.4%; rode in past month: males: 29.9%, females: 19.3%; rode in past year: males: 43.9%, females: 31.1%) (Australian Bicycle Council and Austroads 2013).

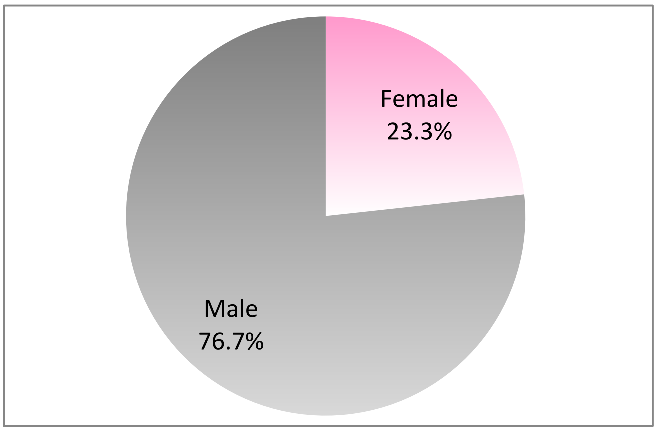


Figure 11 All bike rider crashes in Victoria by gender, 2002–2012

The following three charts show the proportion of bike riders by gender by crash injury outcome.

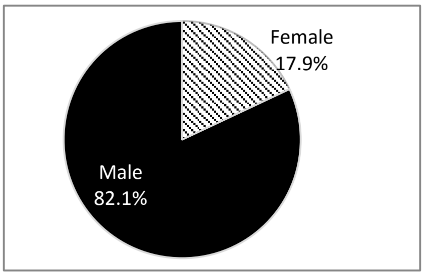


Figure 12 All fatal bike rider crashes in Victoria by gender, 2002-2012

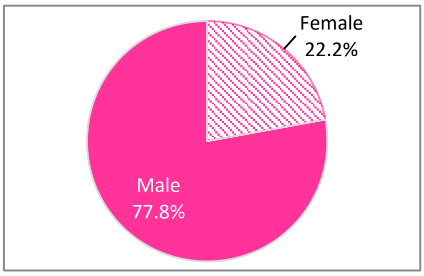


Figure 13 All serious injury bike rider crashes in Victoria by gender, 2002-2012

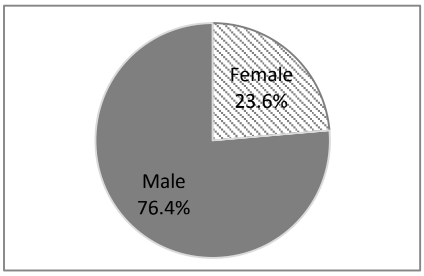


Figure 14 All other injury bike rider crashes in Victoria by gender, 2002-2012

Age

The age distribution is presented by gender in Figure 15. Adult riders (aged over 18 years) were involved in the majority of bicycle rider crashes that were reported to police (84.2%) with a third of all crashes involving bicycle riders aged 30-49 years (34.5%). As discussed in Gender above, this crash distribution is likely to be a function of exposure, as opposed to inherent differences in risk-taking behaviour among particular age groups.

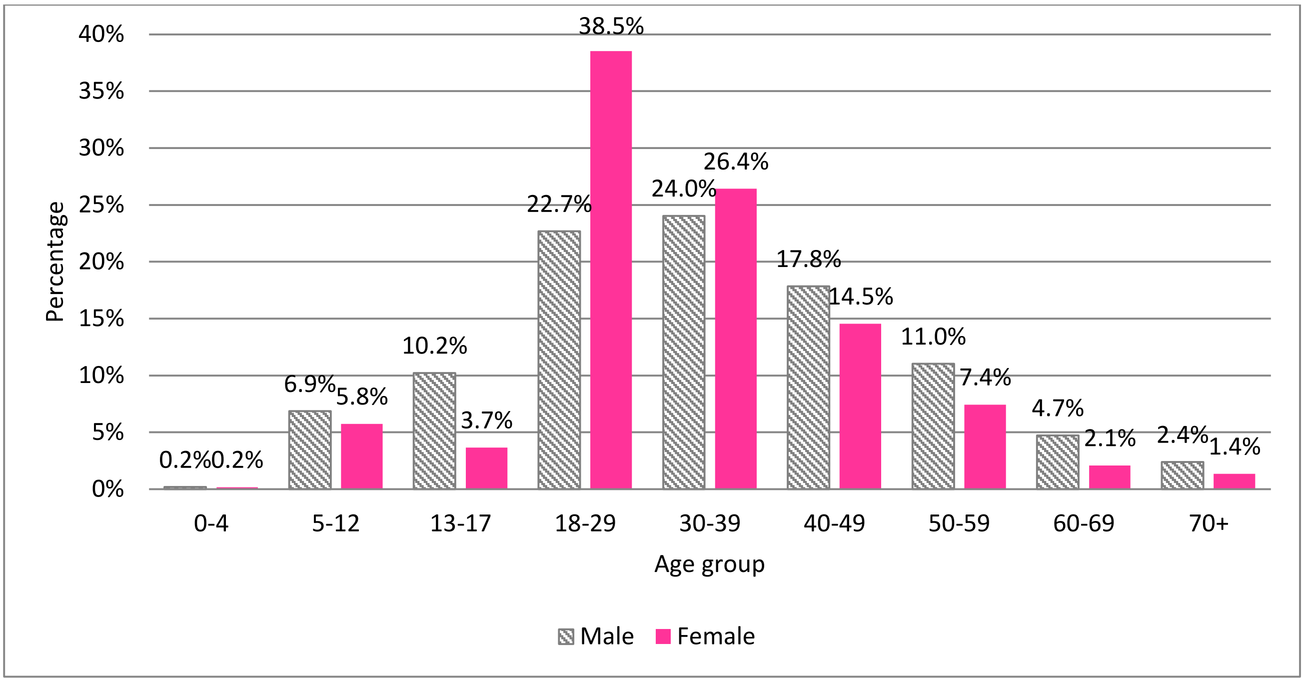


Figure 15 All bike rider crashes in Victoria by age and gender, 2002-2012

The following three charts show the proportion of bike riders by age by crash injury outcome.

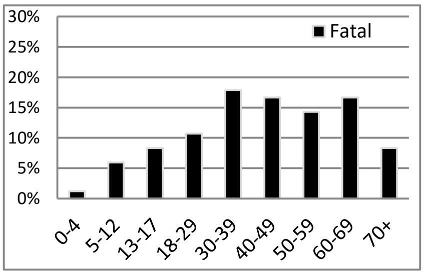


Figure 16 All fatal bike rider crashes in Victoria by age, 2002-2012

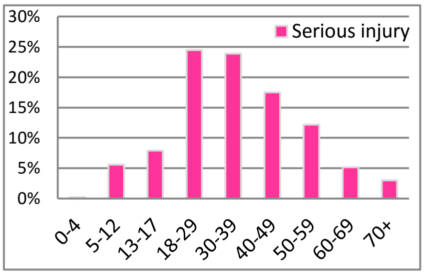


Figure 17 All serious injury bike rider crashes in Victoria by age, 2002-2012

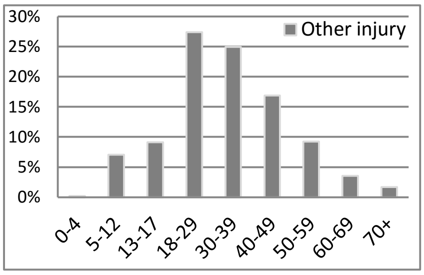


Figure 18 All other injury bike rider crashes in Victoria by age, 2002-2012

Helmet use

Across the study period, three quarters of bike riders (74.6%) were reported to have been wearing a bicycle helmet at the time of the crash. Helmet use is presented per year in Figure 19.

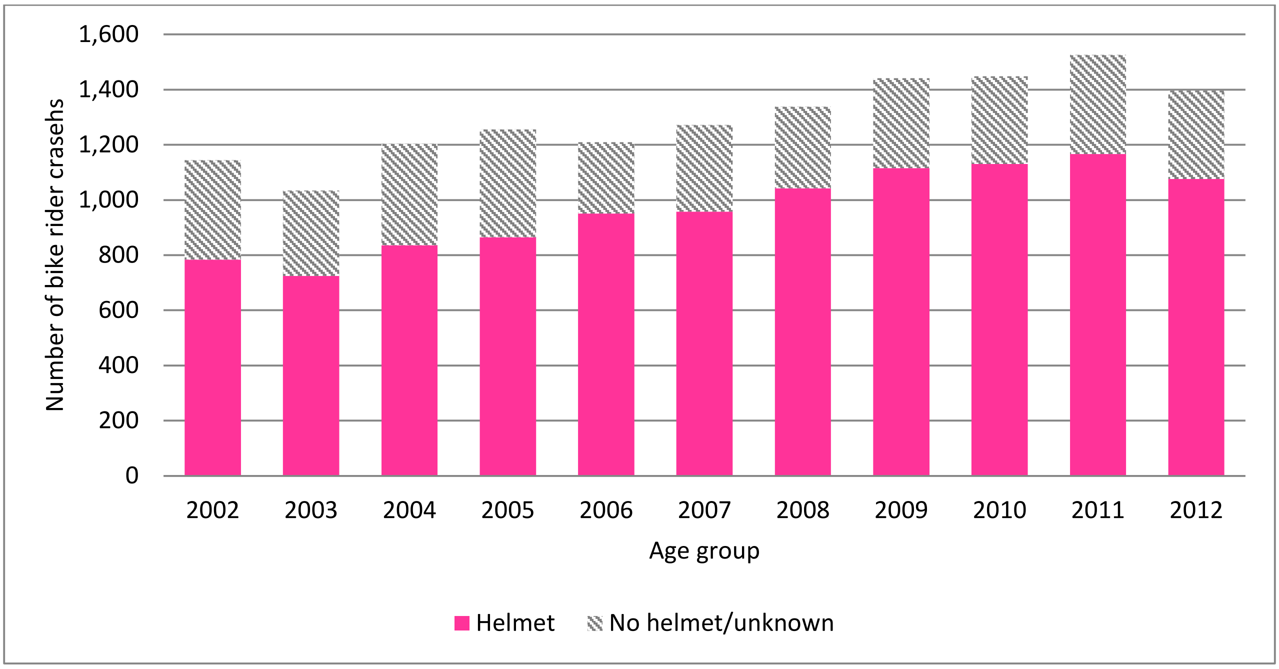


Figure 19 Helmet wearing and non-helmet wearing/unknown by all bike riders for all injury outcome crashes in Victoria, 2002-2012

The following three graphs display the reported percentage of helmet wearing and non-helmet wearing of bike riders who have crashed by injury outcome.

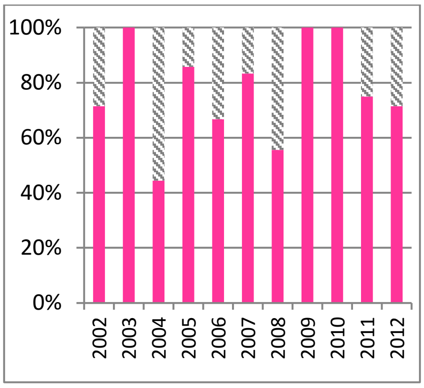


Figure 20 All fatal bike rider crashes in Victoria by helmet wearing and non-wearing/unknown, 2002-2012

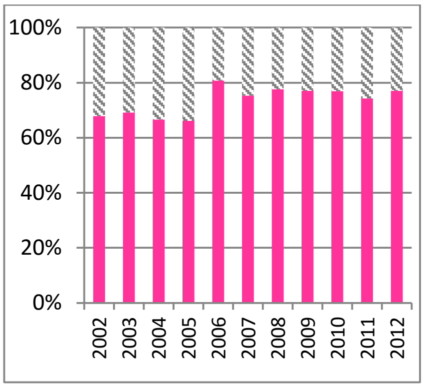


Figure 21 All serious injury bike rider crashes in Victoria by helmet wearing and non-wearing/unknown, 2002-2012

Figure 22 All other injury bike ride crashes in Victoria by helmet wearing and non-wearing/unknown, 2002-2012

4.2.3 Crash characteristics

Time of day

The bike rider crashes were distributed across the day (Table 2, Figure 23). Most crashes occurred during peak travel times, 8am to 10am (19.3%) and 4pm to 6pm (18.6%). The fewest crashes occurred from midnight to 6am (2.2%). Crashes by time of day by injury outcomes are also graphed to illustrate the variation across the three injury categories.

Table 2 All bike rider crashes in Victoria by time of day and injury outcome, 2002–2012

Time of day	Fatal	Serious injury	Other injury	Total	Per cent
Midnight to 6am	3	124	185	312	2.2
6am to 8am	10	525	1035	1570	11.0
8am to 10am	15	830	1908	2753	19.3
10am to midday	11	404	906	1321	9.3
Midday to 2pm	7	424	897	1328	9.3
2pm to 4pm	10	487	1197	1694	11.9
4pm to 6pm	13	847	1794	2654	18.6
6pm to 8pm	11	617	1221	1849	13.0
8pm to midnight	6	319	456	781	5.5
Total	**86**	**4577**	**9599**	**14,254**	**100**

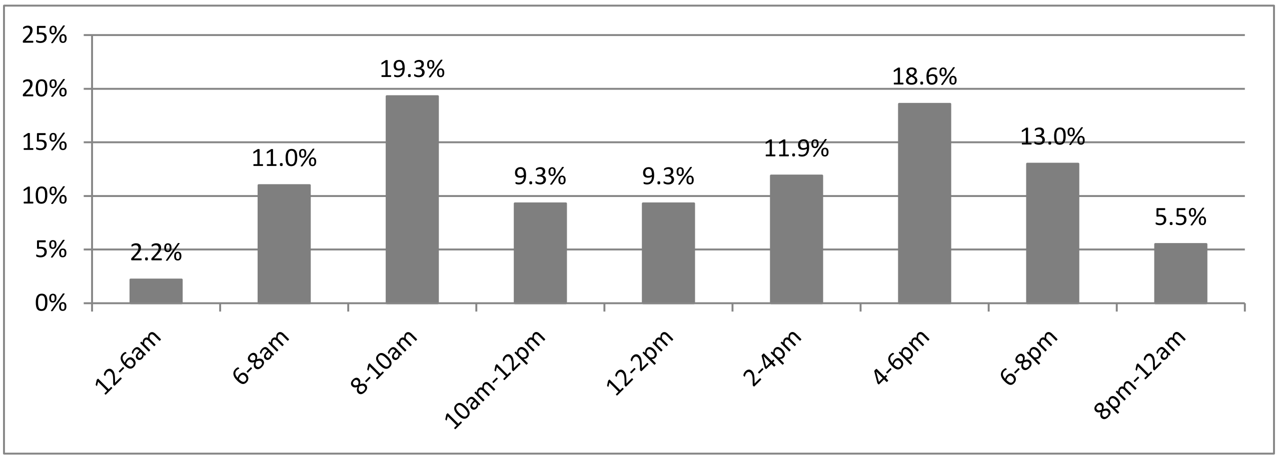


Figure 23 All police-reported bike rider crashes in Victoria by time of day, 2002–2012

The following three charts show the proportion of crashes by time of day by crash injury outcome.

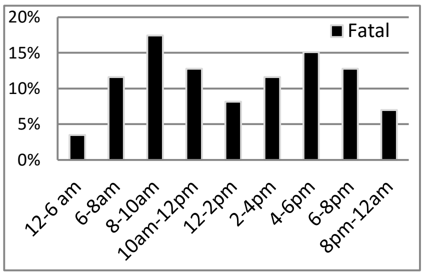


Figure 24 All fatal bike rider crashes in Victoria by time of day, 2002-2012

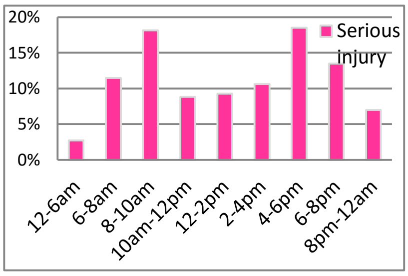


Figure 25 All serious injury bike rider crashes in Victoria by time of day, 2002-2012

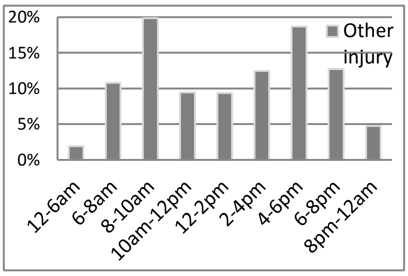


Figure 26 All other injury bike rider crashes in Victoria by time of day, 2002-2012

Light conditions

The majority of all bike rider crashes occurred during the day (76.4%) with 12.5 per cent occurring at night and 10.1 per cent at dusk/dawn (Figure 27). The time the crash occurred was reported for almost all bike rider crashes (99.1%). Crashes by light condition are also included by injury outcome to illustrate the variation in light conditions across the three categories. Again, the high proportion of daytime crashes is likely to be a function of exposure.

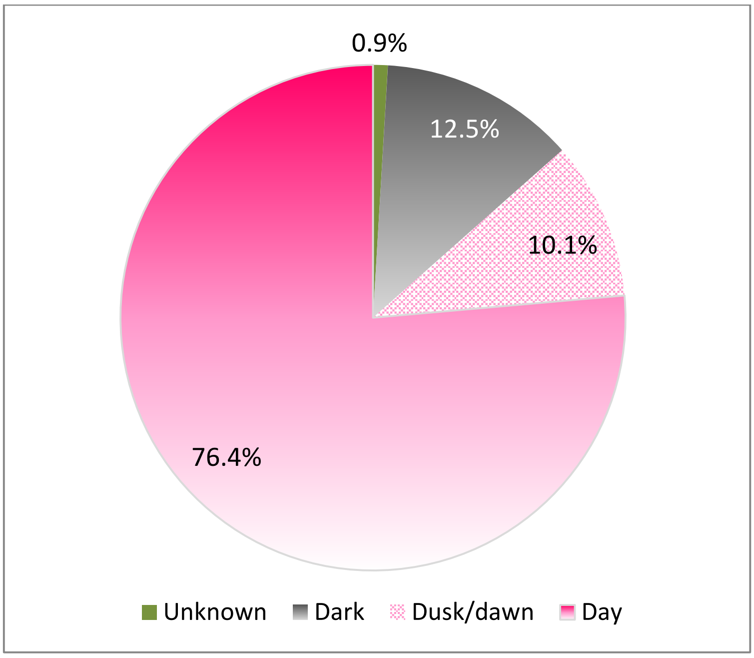


Figure 27 All bike rider crashes in Victoria by light conditions, 2002-2012

The following three charts show the proportion of bike riders by light conditions by crash injury outcome.

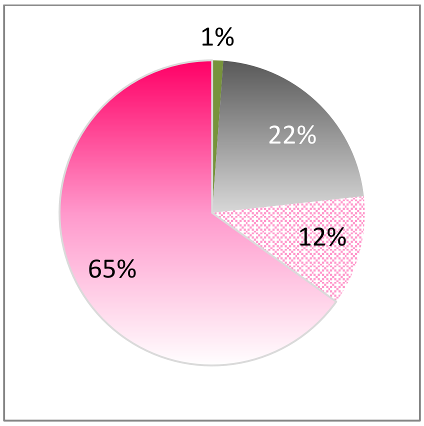


Figure 28 All fatal bike rider crashes in Victoria by light condition, 2002-2012

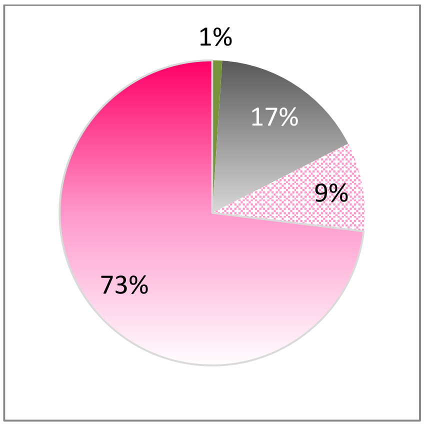


Figure 29 All serious injury bike rider crashes in Victoria by light condition, 2002-2012

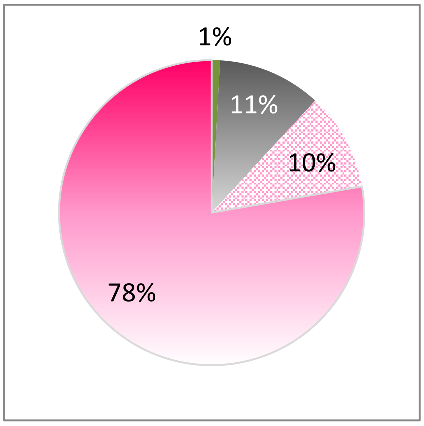


Figure 30 All other injury bike rider crashes in Victoria by light condition, 2002-2012

Day of week

The bike rider crashes were distributed across all days of the week. Most crashes occurred on Tuesday (17.4%) followed by Thursday (16.8%). The least crashes occurred on Sunday (9.1%) (Table 3, Figure 31).

Table 3 All bike rider crashes in Victoria by day of week and injury outcome, 2002-2012

Day of week	Fatal	Serious injury	Other injury	Total	%
Monday	12	658	828	2047	14.3
Tuesday	20	743	1377	2485	17.4
Wednesday	13	721	1722	2313	16.2
Thursday	11	776	1579	2397	16.8
Friday	14	693	1610	2128	14.9
Saturday	7	536	1421	1608	11.3
Sunday	9	455	1065	1292	9.1

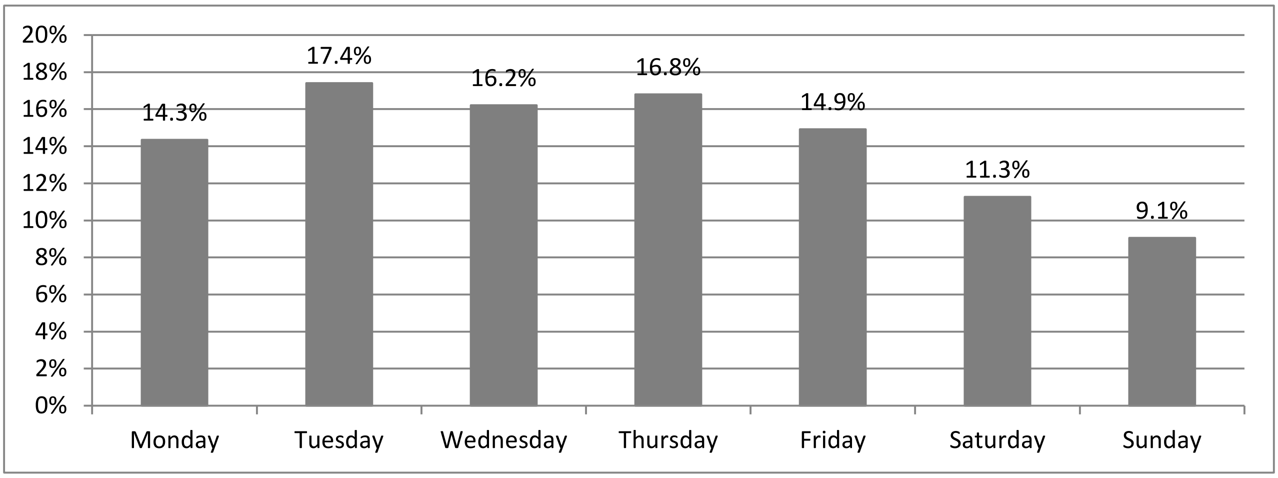


Figure 31 All bike rider crashes in Victoria by day of week, 2002-2012

The following three charts show the proportion of bike riders by day of the week by crash injury outcome.

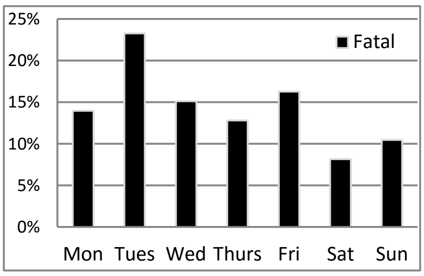


Figure 32 All fatal bike rider crashes in Victoria by day of week, 2002-2012

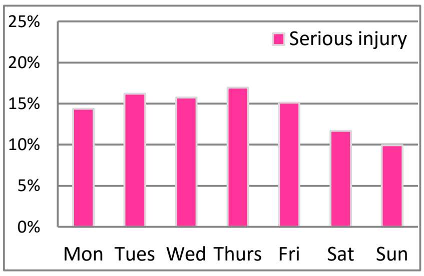


Figure 33 All serious injury bike rider crashes in Victoria by day of week, 2002-2012

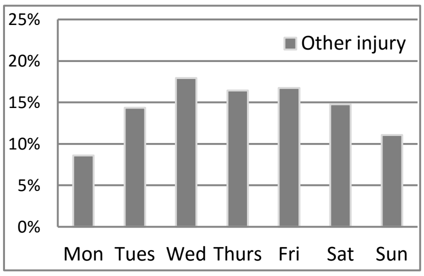


Figure 34 All other injury bike rider crashes in Victoria by day of week, 2002-2012

Month

The bike rider crashes were distributed across all months of the year. The most crashes occurred in March (10.2%), followed by February (9.7%). The fewest crashes occurred in July (7.1%) and June (7.2%) (Table 4, Figure 35).

Table 4 All bike rider crashes in Victoria by month of year and injury outcome, 2002-2012

Month	Fatal	Serious injury	Other injury	Total	%
January	13	371	741	1125	7.9
February	5	434	948	1387	9.7
March	10	507	942	1459	10.2
April	7	391	801	1199	8.4
May	5	361	890	1256	8.8
June	2	331	699	1032	7.2
July	6	311	699	1016	7.1
August	7	374	742	1123	7.9
September	8	309	747	1064	7.5
October	6	424	817	1247	8.7
November	4	394	829	1227	8.6
December	13	375	747	1135	8.0

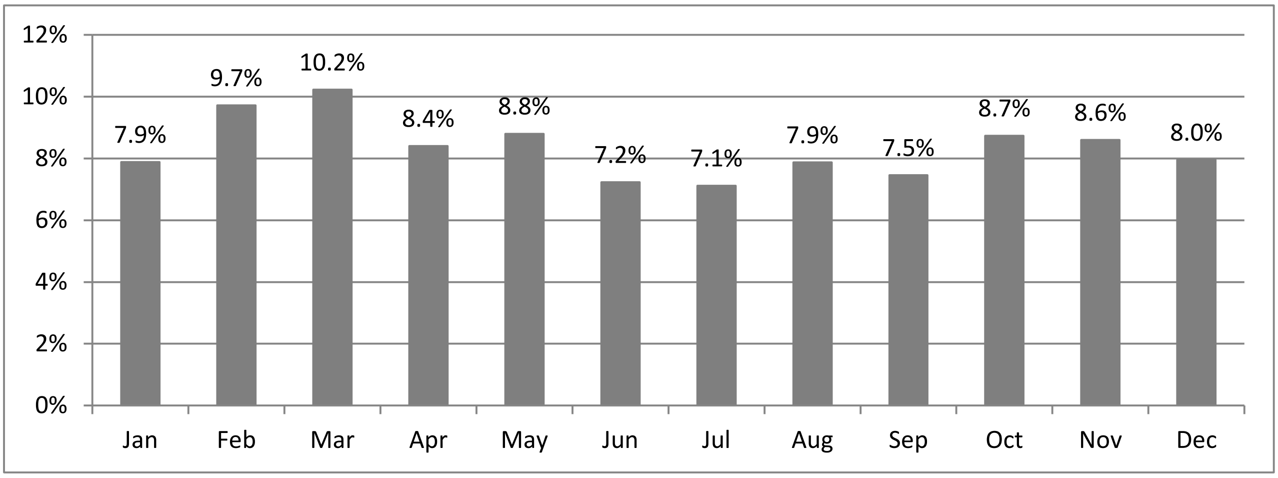


Figure 35 All bike rider crashes in Victoria by month of year, 2002-2012

The following three charts show the proportion of bike riders by month by crash injury outcome.

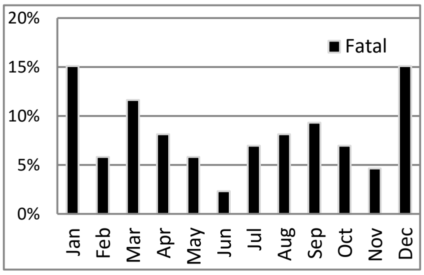


Figure 36 All fatal bike rider crashes in Victoria by month, 2002-2012

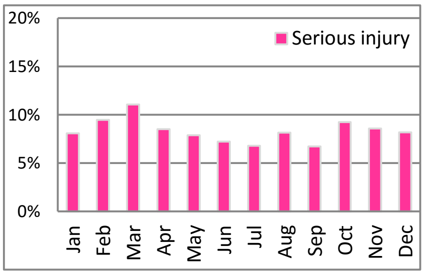


Figure 37 All serious injury bike rider crashes in Victoria by day of week, 2002-2012

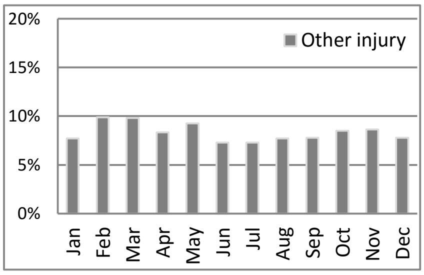


Figure 38 All other injury bike rider crashes in Victoria by day of week, 2002-2012

Location

The majority of bike rider crashes occurred in metropolitan Melbourne. While over 80 per cent of all non-fatal crashes occurred in metropolitan Melbourne, almost half of all fatalities (48%) occurred in regional Victoria.

Table 5 All bike rider crashes in Victoria by location and injury outcome, 2002-2012

Location	Fatal	Serious injury	Other injury	Total	Percent
Metro Melbourne	45	3675	7837	11559	81.1
Regional Victoria	41	912	1746	2699	18.9

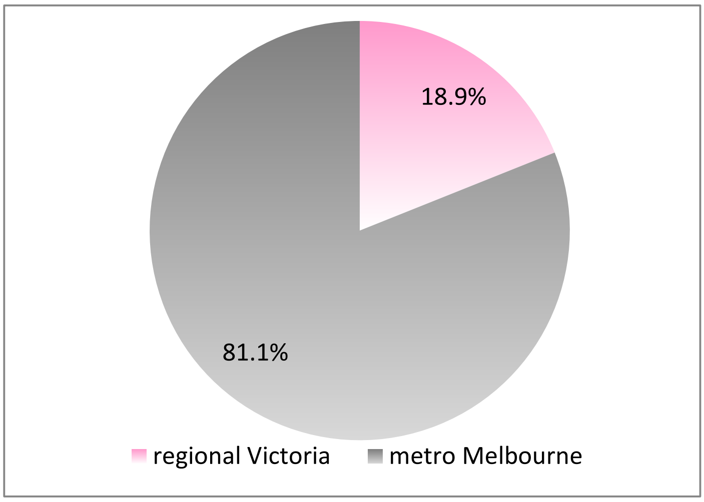


Figure 39 All bike rider crashes in Victoria by location, 2002-2012

The following three charts show the proportion of bike riders by location (metropolitan Melbourne and regional Victoria) by crash injury outcome.

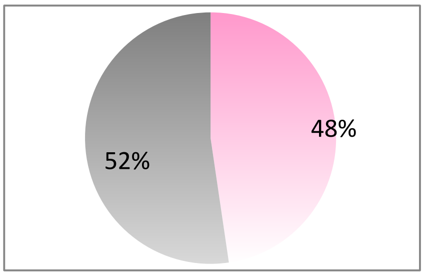


Figure 40 All fatal bike rider crashes in Victoria by location, 2002-2012

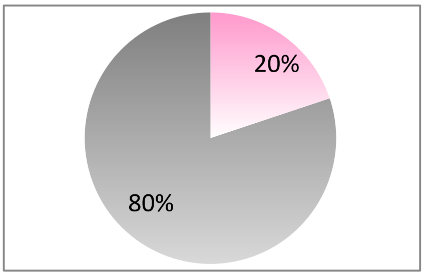


Figure 41 All serious injury bike rider crashes in Victoria by location, 2002-2012

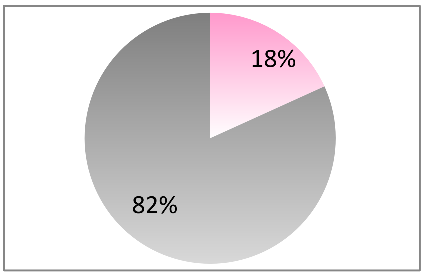


Figure 42 All other injury bike rider crashes in Victoria by location, 2002-2012

Location – geometry

The majority of bike rider crashes occurred at an intersection (60%). Intersections include cross intersections, T intersections, Y intersections and multiple intersections. Sections of road defined as not an intersection include midblock, dead end, road closure and private property. Crashes where the road geometry was unknown were excluded. Fatality crashes differ from non-fatal crashes, with two thirds occurring at non-intersection locations.

Table 6 All bike rider crashes in Victoria by location and injury outcome, 2002-2012

Geometry	Fatal	Serious injury	Other injury	Total	Percent
Cross intersection	14	1205	2818	4038	28.4
Other intersection	15	1467	3029	4511	31.7
Not at intersection	56	1904	3729	5689	40.0

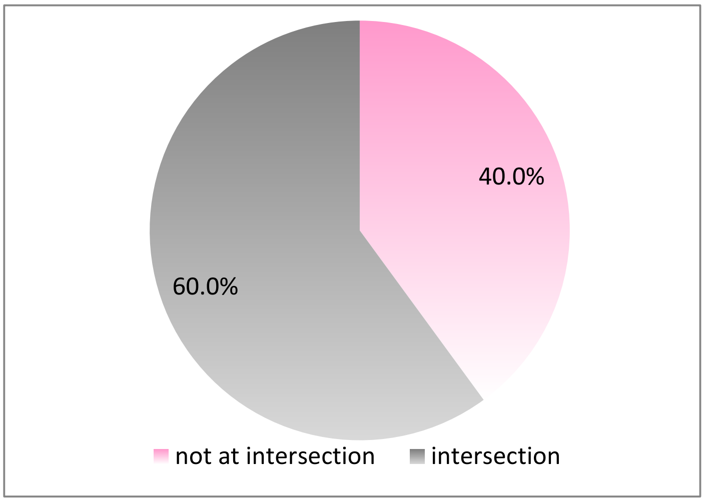


Figure 43 All bike rider crashes in Victoria by geometry, 2002-2012

The following three charts show the proportion of bike riders crashes by geometry pink: not at intersection, grey: at intersection) by crash injury outcome.

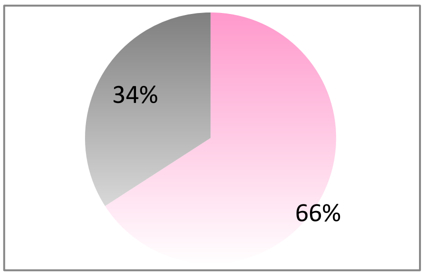


Figure 44 All fatal bike rider crashes in Victoria by geometry, 2002-2012

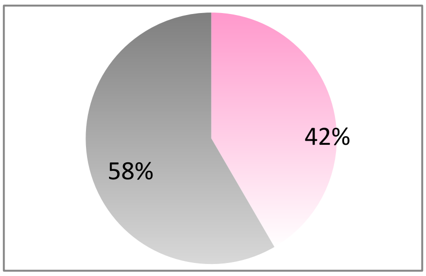


Figure 45 All serious injury bike rider crashes in Victoria by geometry, 2002-2012

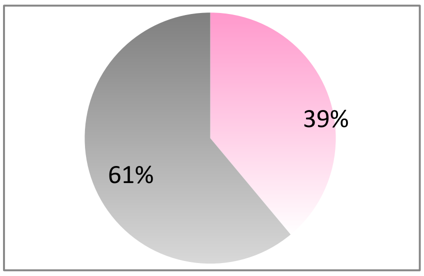


Figure 46 All other injury bike rider crashes in Victoria by geometry, 2002-2012

Crash type

The majority of crashes reported involved a crash with a vehicle (90%). A summary of crash types is included below. 'No crash and no object struck' refers to single-vehicle crashes, that is, when the bike rider fell from or crashed their bike and no counterpart or object was involved in causing the crash.

Note: caution is needed when using the data below, as these crash numbers are based on police-reported crashes and are not likely to include either crashes that did not involve a motor vehicle or bicycle-rider only crashes. For further details, see Section 2.1 above.

Table 7 All bike rider crash types in Victoria, 2002-2012

Crash type	n	Percent
Collision with vehicle	12,792	89.6
Struck pedestrian	195	1.4
Struck animal	36	0.3
Collision with fixed object	101	0.7
Collision with some other object	55	0.4
Vehicle overturned (no collision)	70	0.5
Fall from or in moving vehicle (bicycle)	69	0.5
No collision and no object struck	946	6.6
Other crash	6	0.0
Total	14,270	100

The majority of all bike rider crashes reported in CrashStats involved a crash with a vehicle, across all injury outcome categories as follows:

- Cyclists involved in a crash with a vehicle
  - 87% fatality crashes
  - 86% serious injury crashes
  - 91% other injury crashes

Vehicles involved

Cars were the most commonly reported partner vehicle of crashes (Table 8). The list of vehicles involved in bike rider crashes generated by CrashStats includes the bicycle of the bike rider; however, it does not show where multiple bicycles may have been involved in a crash. Further, the number of bike riders involved in crashes in the period (14,270) is fewer than the number of bicycles involved in reported crashes (14,635). It is assumed that the additional bicycles include crashes where the counterpart was a bike rider and crashes that involved multiple bike riders, some of whom were not injured.

All vehicles involved in bike rider crashes, including bicycles, are included in Table 8; however, bicycles have been excluded from the following analysis.

Table 8 Vehicles involved in bike rider crashes, Victoria, 2002-2012

Vehicle type	n	Percent
Car	8466	30.0
Station wagon	2112	7.5
Taxi	409	1.4
Utility	849	3.0
Panel van	399	1.4
Prime mover (no of trailers unknown)	50	0.2
Rigid truck (weight unknown)	138	0.5
Prime mover only	5	0.0
Prime mover- single trailer	31	0.1
Prime mover B-Double	13	0.0
Prime mover B-Triple	0	0.0
Light commercial vehicle (rigid) <= 4.5 tonnes	111	0.4
Heavy vehicle (rigid) > 4.5 tonnes	119	0.4
Bus/coach	103	0.4
Mini bus	14	0.0
Motor cycle	79	0.3
Moped	0	0.0
Motor scooter	7	0.0
Bicycle	14636	51.8
Horse	0	0.0
Tram	40	0.1
Train	4	0.0
Other vehicle	62	0.2
Not applicable	3	0.0
Not known	615	2.2
Total	28265	100.0

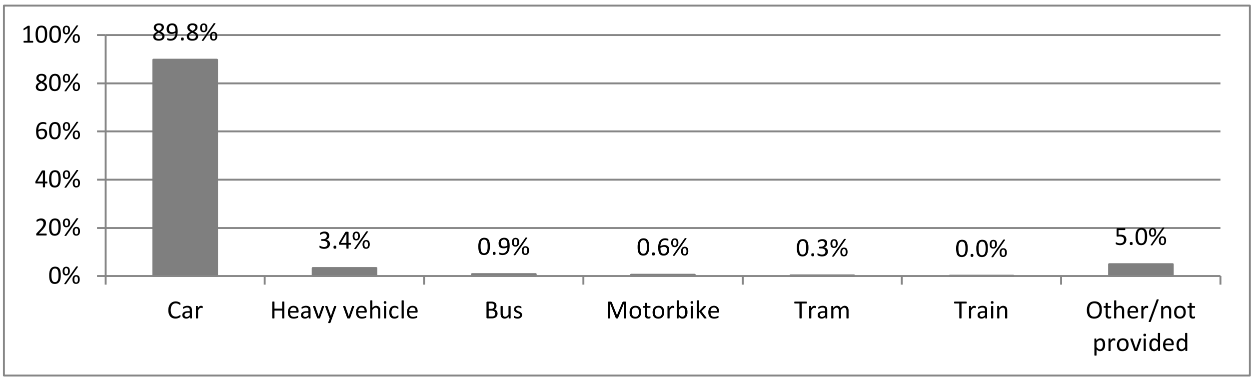


Figure 47 All bike rider crashes in Victoria by vehicle involved (grouped, excluding bicycles), 2002-2012

All counterpart road users were grouped by type and analysed by bike rider injury outcome; see list below.

Vehicle type	Study classification
Car	Car
Station wagon	
Taxi	
Utility	
Panel van	
Prime mover (no of trailers unknown)	Heavy vehicle
Rigid truck (weight unknown)	
Prime mover only, single trailer, B double, B triple	
Light commercial vehicle (rigid) <=4.5 tonnes	
Heavy vehicle (rigid) > 4.5 tonnes	
Bus/coach	Bus
Mini bus	
Motorcycle	Motorbike
Moped	
Motorscooter	
Tram	Tram
Train	Train
Other	Other
Not known	

Table 9 Bike rider crashes involving a vehicle (excluding bicycles): grouped vehicles by injury outcome

	Fatality		Serious injury		Other injury		Total	
Car	43	55.1	3749	88.0	8443	90.9	12235	89.8
Heavy vehicle	27	34.6	206	4.8	234	2.5	467	3.4
Bus	3	3.8	38	0.9	76	0.8	117	0.9
Motorbike	2	2.6	39	0.9	45	0.5	86	0.6
Tram	1	1.3	21	0.5	18	0.2	40	0.3
Train	1	1.3	3	0.1	0	0.0	4	0.0
Other/not provided	1	1.3	205	4.8	471	5.1	677	5.0
	78	100.0	4261	100.0	9287	100.0	13626	100.0

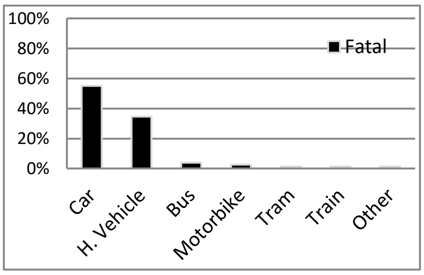


Figure 48 All fatal bike rider crashes in Victoria by counterpart, 2002-2012

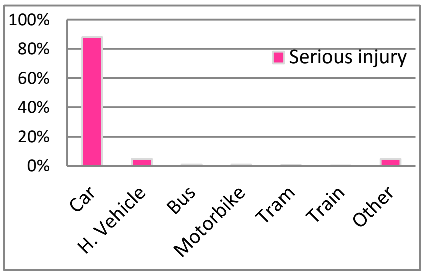


Figure 49 All serious injury bike rider crashes in Victoria by counterpart, 2002-2012

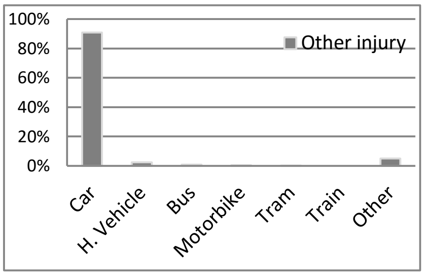


Figure 50 All other injury bike rider crashes in Victoria by counterpart, 2002-2012

Crash mechanism – grouped

The crash types are first discussed in their grouped categories, followed by an analysis that highlights the most common crash type for each injury outcome.

Table 10 Grouped crash mechanism for all bike rider crashes in Victoria (2002-2012)

Grouped DCA		**n**	**Percent**
130-139	Vehicles from same direction	3221	22.6
140-149	Manoeuvring	2822	19.8
120-129	Vehicles from opposing directions	1823	12.8
110-119	Vehicles from adjacent directions (intersections only)	1762	12.3
160-169	On path (including dooring)	1711	12.0
100-109	Pedestrian on foot	1604	11.2
170-179	Off path on straight	1118	7.8
150-159	Overtaking	90	0.6
190-199	Passenger and miscellaneous	62	0.4
180-189	Off path on curve	57	0.4
Total		**14270**	100

The five most frequent bike rider crashes grouped by DCA type by injury outcome are shown below.

Fatality crashes

- 49% Vehicles from the same direction (DCA 130–139)
- 14% Vehicles from opposing directions (DCA 120–129)
- 13% Manoeuvring (DCA 140–149)
- 9% Off path on straight (DCA 170–179)
- 6% Vehicles from adjacent directions (intersections only) (DCA 100-109)

Serious injury

- 20% Vehicles from the same direction (DCA 130–139)
- 18% Manoeuvring (DCA 140–149)
- 14% Vehicles from opposing directions (DCA 120–129)
- 13% On path (including dooring) (DCA 160–169)
- 11% Vehicles from adjacent directions (intersections only) (DCA 100-109)

Other injury

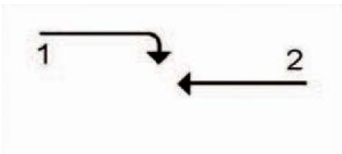
- 23% Vehicles from the same direction (DCA 130–139)
- 21% Manoeuvring (DCA 140–149)
- 13% Vehicles from adjacent directions (intersections only) (DCA 110–119)
- 12% Vehicles from opposing directions (DCA 120–129)
- 12% On path (including dooring) (DCA 160–169)

Crash mechanism – individual

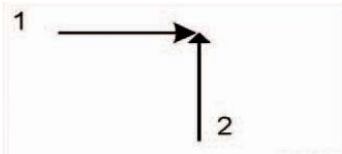
Six crash classifications were used by Victoria Police to describe half (52.3%) of the 14,270 crashes (Table 11). Diagrams that illustrate these most common crash types are included below (Figure 51).

Table 11 Most frequent bike rider crashes (all) by DCA type, Victoria, 2002–2012

Crash classification (DCA)	**n**	**Per cent**
Right through (DCA 121)	1601	11.2
Cross traffic (intersection only) (DCA 110)	1408	9.9
Vehicle strikes door of parked/stationary vehicle (DCA 163)	1247	8.7
Vehicle off footpath strikes vehicle on carriageway (DCA 148)	1180	8.3
Vehicle strikes another vehicle while emerging from driveway-lane (DCA 147)	1159	8.1
Out of control on carriageway (DCA 174)	868	6.1
Total	7463	52.3

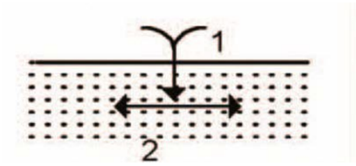


Right through (DCA 121)

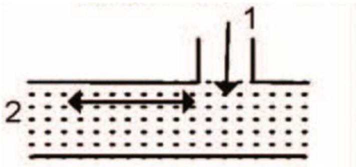


Cross through (DCA 110)

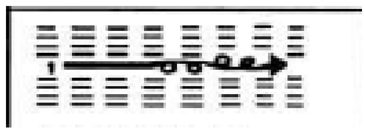
Vehicle door (DCA 163)



From footway (DCA148)



Emerging from driveway/lane (DCA147)



Out of control on carriageway (DCA174)

Figure 51 DCA codes and graphic representation of 6 most frequent bike rider crash types in Victoria, 2002-2012

Table 12 Most frequent bike rider crashes by DCA type by injury outcome, Victoria, 2002–2012

Fatal	**%**	**Serious injury**	**%**	**Other injury**	**%**
Rear end (DCA 130)	25.6	Right through (DCA 121)	12.5	Right through (DCA 121)	10.7
Off footpath (DCA 148)	11.6	Cross traffic (DCA 110)	9.8	Cross traffic (DCA 110)	9.9
Head on, not overtaking (DCA 120)	8.1	Off footpath (DCA 148)	8.9	Vehicle door (DCA 163)	9.4
Lane side swipe, vehicles in parallel lanes (DCA 133)	7.0	Out of control on carriageway, on straight (DCA 174)	7.8	Emerging from driveway/ lane (DCA 147)	9.1
Right through (DCA 121)	5.8	Vehicle door (DCA 163)	7.5	Off footpath (DCA 148)	7.9
Left turn sideswipe (DCA 137)	5.8	Emerging from driveway/ lane (DCA 147)	6.3	Left turn sideswipe (DCA 137)	6.6

Speed zones

The majority of all bike rider crashes (76.6%) occurred in 50kph and 60kph speed zones. This is likely to reflect the high proportion of Victorian roads that have a speed limit of 50kph or 60kph and the likelihood that a high proportion of bike riders ride on these roads on each bike trip.

Note: speed was listed as 'unknown' for a proportion of bike rider crashes, across all injury outcome types. This is included in the figures below to accurately represent the available data and highlight that this was a gap across fatality, serious injury and other injury crashes.

Table 13 All police reported bike rider crashes by speed zone, Victoria, 2002–2012

Speed zone	n	%
40kph	707	5.0%
50kph	4280	30.1%
60kph	6635	46.6%
70kph	749	5.3%
75kph	4	0.0%
80kph	708	5.0%
90kph	18	0.1%
100kph	327	2.3%
110kph	5	0.0%
Other	20	0.1%
Off road	35	0.2%
Not known	753	5.3%
	14241	100.0%

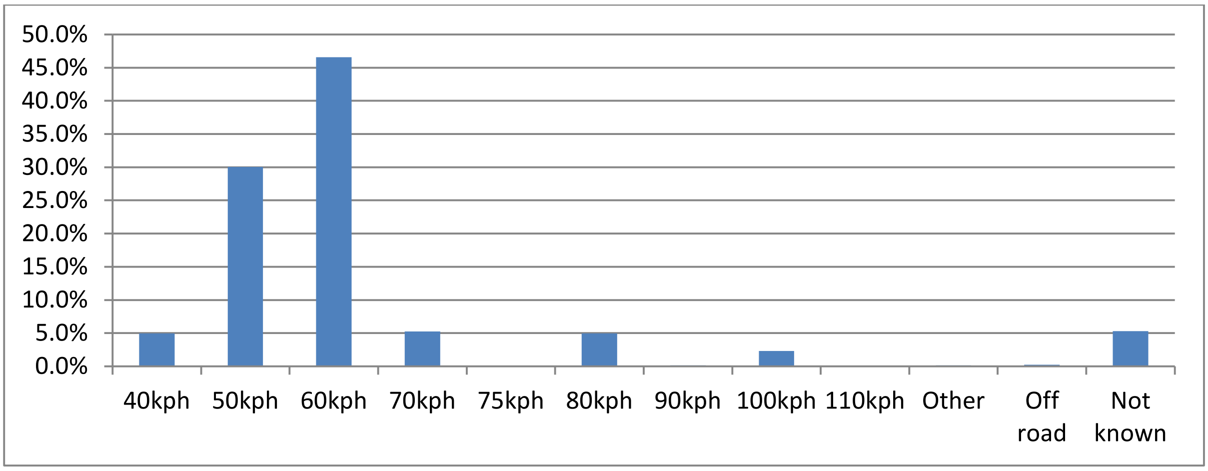


Figure 52 All bike rider crashes in Victoria by speed zones, 2002-2012

The following three charts show the proportion of bike riders crashes by speed zone by crash injury outcome. Other locations and off road have been excluded in these breakdowns.

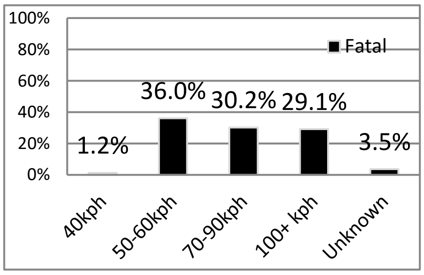


Figure 53 All fatal bike rider crashes in Victoria by speed zone, 2002-2012

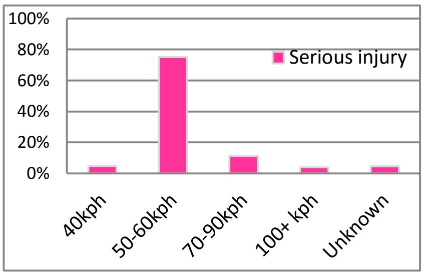


Figure 54 All serious injury bike rider crashes in Victoria by speed zone, 2002-2012

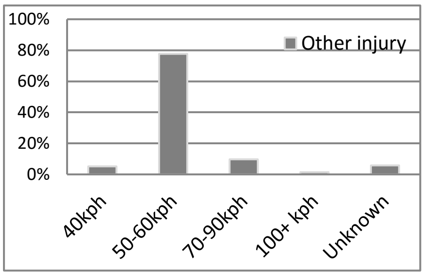


Figure 55 All other injury bike rider crashes in Victoria by speed zone, 2002-2012

Crashes in 50kph and 60kph speed zones

The majority of bike rider crashes, 10,915 (76.6%), occurred in 50kph and 60kph speed zones, that is, local streets and neighbourhoods. These crashes included:

- 31 fatality crashes (36.0% of all bike rider fatality crashes 2002–2012)
- 3436 serious injury crashes (75.2% of all bike rider serious injury crashes 2002–2012)
- 7448 other injury crashes (77.7% of all bike rider other injury crashes 2002–2012)

For the serious injury and other injury bike rider crashes, the profile of the crashes has already been discussed above, as for each of these injury classifications, the majority of crashes occurred in these low-speed locations.

The crash circumstances for all 31 people killed following a bicycle crash were analysed and there was considerable variation between the crash events. Some of the key factors that were identified for the crashes that occurred in 50kph and 60kph speed zones included:

- 13 (41.9%) involved a heavy vehicle
- 12 occurred in the daytime
- 12 occurred in the metropolitan Melbourne area
- 7 occurred at intersections
- 5 involved a left-turn sideswipe
- 4 involved the bike rider leaving the footpath and being struck by a heavy vehicle on the carriageway
- All crashes occurred in clear, dry conditions.

4.3 Area analysis of bike rider crashes (2002–2012)

All bike rider crashes

Crash clusters are seen in regions with high population density, such as Melbourne’s metropolitan and urban regions, and areas popular with bike riding (e.g. along scenic routes).

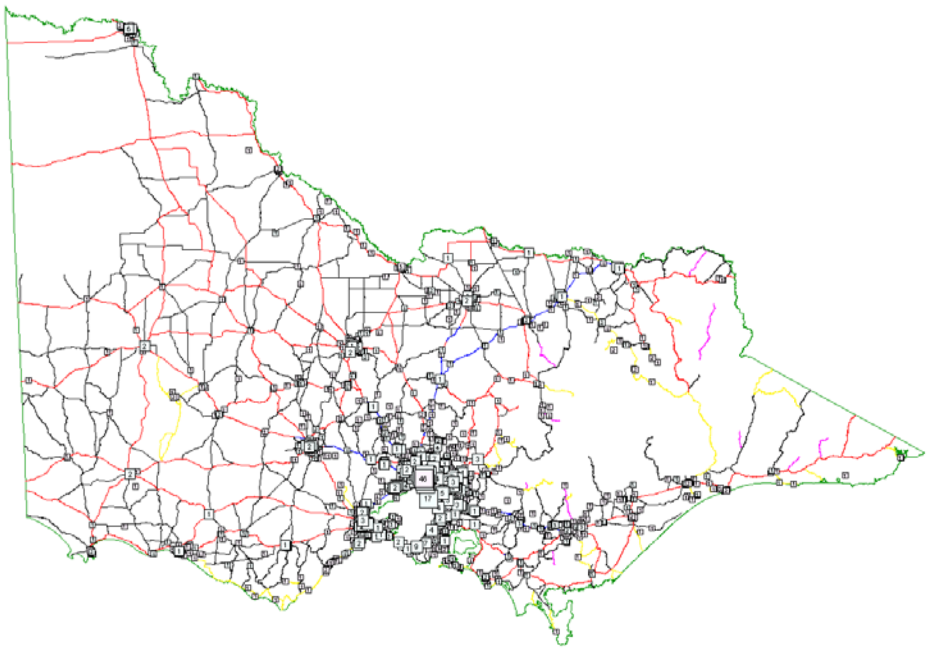


Figure 56 All police-reported bike rider road crashes in Victoria, 2002–2012

Fatality crashes

All police-reported bicycle rider fatality crashes that occurred in Victoria from 2002 to 2012 are mapped below. Figure 57 shows all fatality crash locations for the state. Figure 58 shows the fatality bike rider crashes in the Melbourne metropolitan area.

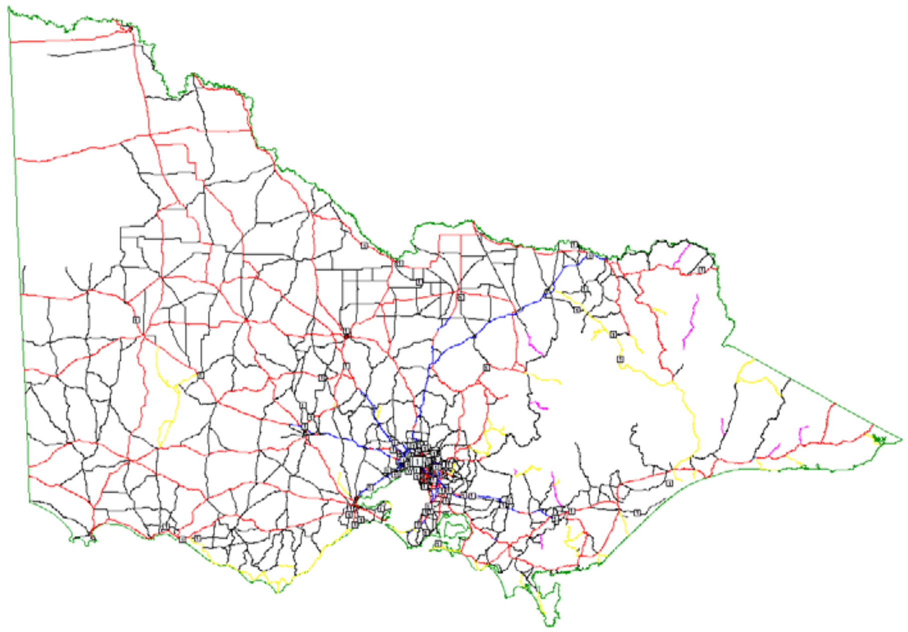


Figure 57 Map of fatal bike rider crashes in Victoria, 2002–2012

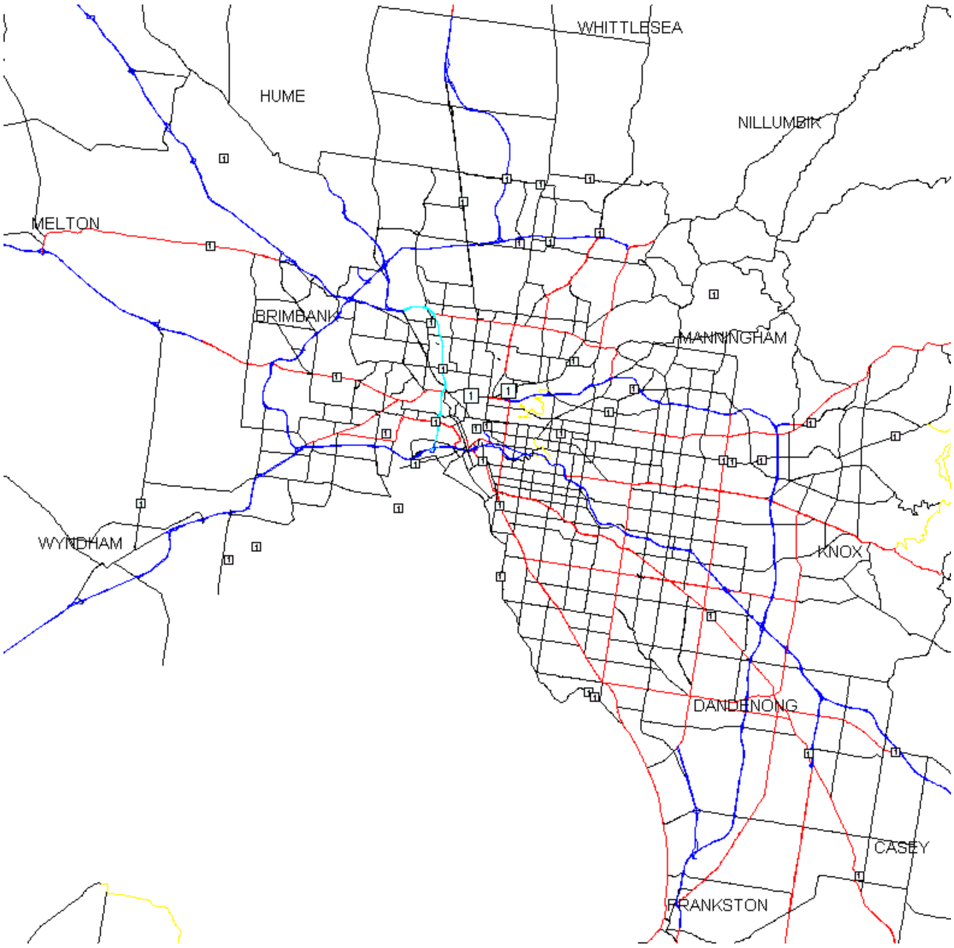


Figure 58 Cluster of fatal bike rider road crashes in Melbourne metropolitan area, 2002–2012

Serious injury crashes

All police-reported bicycle rider serious injury crashes that occurred in Victoria from 2002 to 2012 are mapped in Figure 59. Crashes resulting in bike rider serious injury outcomes were reported across Victoria, with higher incidence among more densely populated locations. All bicycle rider other injury crashes that occurred in Victoria from 2002 to 2012 are mapped in Figure 60 below.

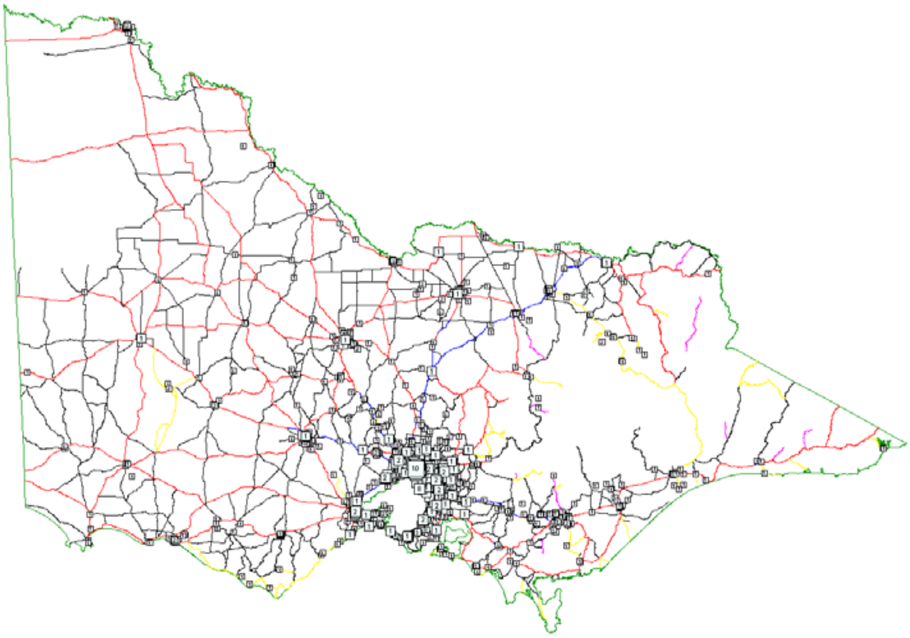


Figure 59 Map of serious injury bike rider crashes in Victoria, 2002–2012

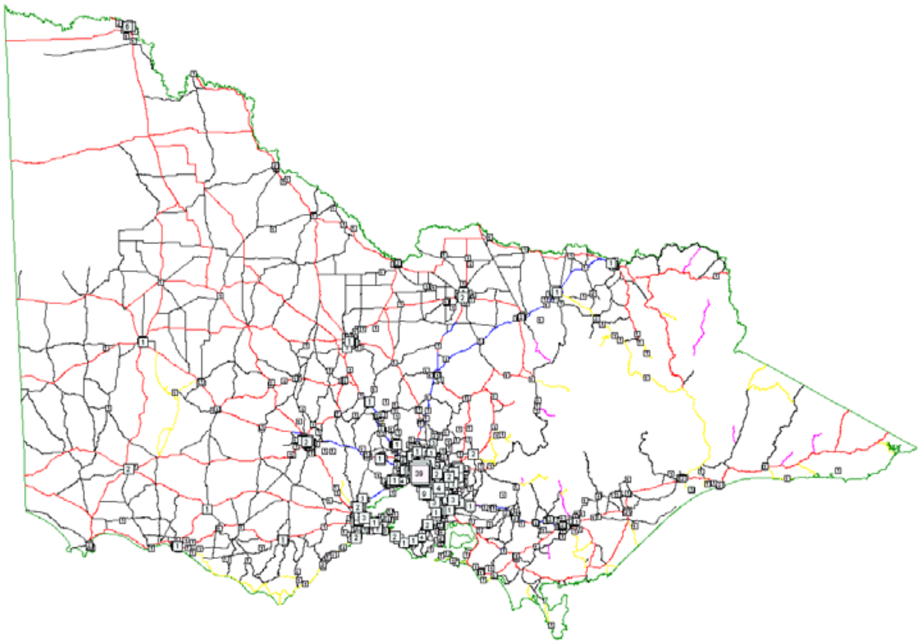


Figure 60 Bike rider road crashes in Victoria 2002–2012 which resulted in other injuries

4.3.1 Crashes by Victorian municipality

Bicycle crashes were analysed for all municipalities in Victoria for the period from 2002 to 2012. The 20 municipalities with the highest total numbers of bike rider crashes and the proportion of crashes for that municipality as a percentage of the state-wide bike crashes are listed in the table below.

Table 14 Top 20 municipalities for all police-reported bike rider crashes, Victoria, 2002–2012

Municipality	n	%
Melbourne	2031	13.7
Yarra	1281	8.7
Port Phillip	997	6.7
Boroondara	663	4.5
Moreland	619	4.2
Bayside	548	3.7
Kingston	539	3.6
Stonnington	530	3.6
Darebin	468	3.2
Geelong	455	3.1
Glen Eira	446	3.0
Mornington Peninsula	381	2.6
Monash	342	2.3
Monee Valley	305	2.1
Dandenong	262	1.8
Frankston	254	1.7
Whitehorse	250	1.7
Bendigo	249	1.7
Knox	240	1.6
Casey	234	1.6
Total	11094	75.1

Table 15 Top municipalities for bike rider crashes by injury outcomes, Victoria, 2002-2012

Fatal	%	Serious injury	%	Other injury	%
Whittlesea	6.8	Melbourne	12.2	Melbourne	14.5
Geelong	5.7	Yarra	8.5	Yarra	8.8
Melbourne	5.7	Port Phillip	6.9	Port Phillip	6.7
Mornington Peninsula	4.5	Boroondara	5.2	Moreland	4.6
		Bayside	4.6	Boroondara	4.1
Total	22.7	Total	37.4	Total	38.7

4.3.2 Fatality crashes

One in five (21.3%) bike rider fatality crashes in Victoria from 2002 to 2012 occurred in four municipalities: Whittlesea, Geelong, Melbourne and Mornington Peninsula.

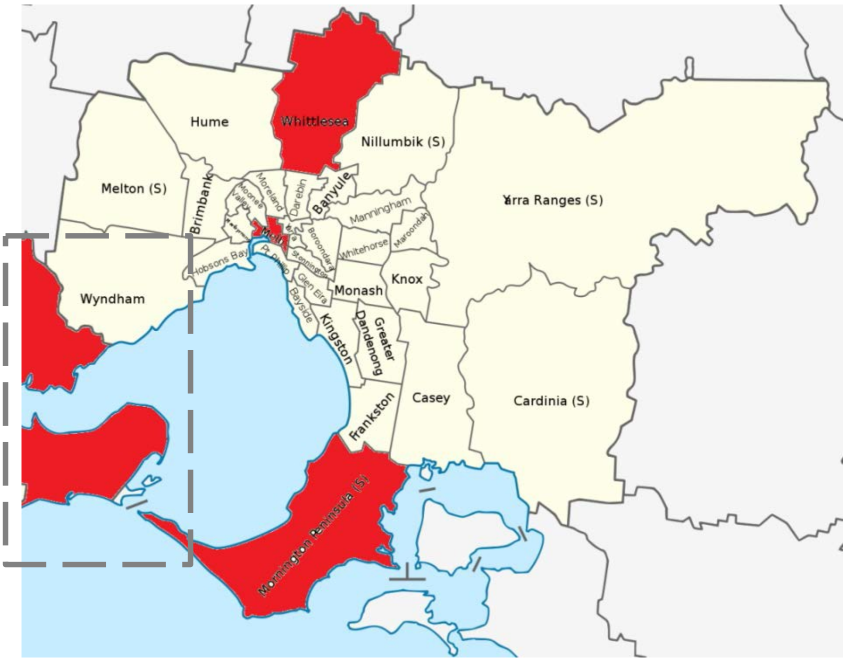


Figure 61 Map of metropolitan Melbourne indicating the municipalities with the most bike rider fatalities (2002–2012) (dashed box outlines the municipality of Geelong)

The other 69 bike rider fatality crashes occurred across Victoria, as included in Table 16.

Table 16 Numbers of bike rider fatality crashes in Victorian municipalities, 2002–2012

No. bike rider fatality crashes	Municipality
3	Boroondara, Campaspe, Port Phillip, Whitehorse
2	Alpine, Baw Baw, Cardinia, Casey, Dandenong, Hepburn, Hobsons Bay, Hume, Indigo, Kingston, Latrobe, Maribyrnong, Maroondah, Mount Alexander, Moyne, Surf Coast, Yarra
1	Ballarat, Banyule, Bass Coast, Bayside, Bendigo, East Gippsland, Frankston, Horsham, Mansfield, Melton, Moonee Valley, Moreland, Nillumbik, Northern Grampians, Shepparton, Towong, Wangaratta, Warrnambool, Wellington, Wodonga, Wyndham Yarra Ranges

4.3.3 Municipalities where bike rider crashes are increasing

A third of all crashes in Victoria (34.8%) between 2002 and 2012 occurred in five municipalities: Melbourne, Yarra, Port Phillip, Boroondara and Moreland.

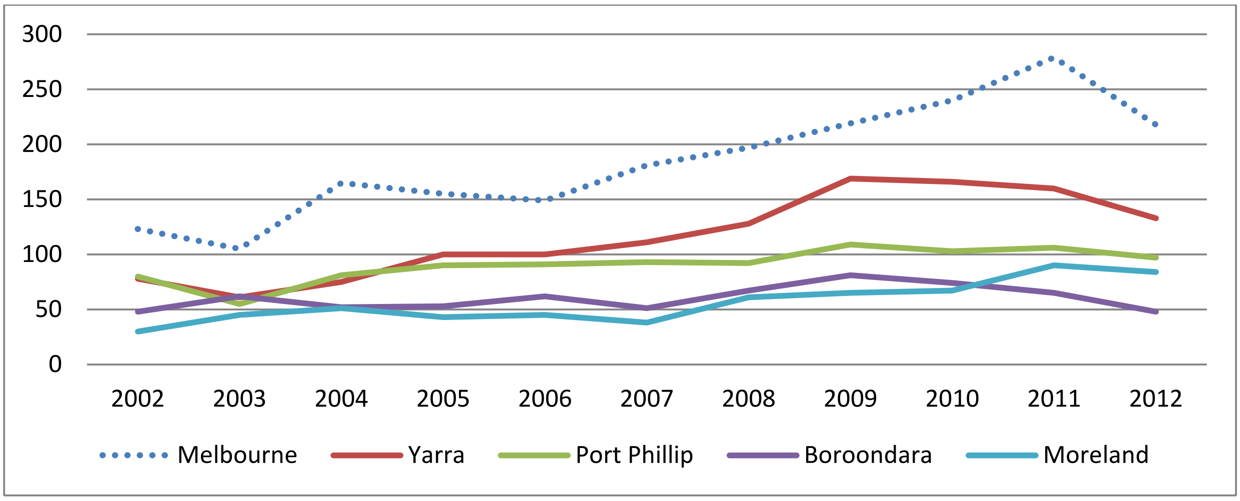


Figure 62 Total number of crashes in municipalities with the highest number of bike rider crashes (2002-2012)

In Figure 63, the municipalities in red are those with the highest number of bike rider crashes. The map provides a clear illustration of the density of the crashes occurring in the inner city/inner suburb areas.

Figure 63 Map of metropolitan Melbourne indicating the municipalities with the most bike rider crashes (all injury outcome crash types) (2002-2012)

Bike rider crash numbers for each of the four municipalities with the highest number of bike rider crashes were analysed. **Note:** Cycling exposure data are not available and are likely to have had an impact on the number of bike rider crashes.

4.3.4 City of Melbourne

The City of Melbourne had the highest number of bike rider crashes per year across the study period, with crashes in the Melbourne CBD itself almost doubling from 2002 to 2012. The majority of bike rider crashes occurred in the eastern side of the city in the proximity of high-density commercial offices and educational institutions when compared to the western side of the city, which is comprised of light-industrial and low–medium density offices.

The most common crash type in the municipality of Melbourne involved unexpectedly opened vehicle doors (DCA 163). Over 1 in 5 bike rider crashes (n=453, 22.3%) (including fatality, serious injury and other injury outcomes) from 2002 to 2012 were due to dooring. Figure 64 and Figure 65 map the crashes that occurred in the municipality of Melbourne in 2002 and in 2012, and clearly illustrate the increase in the number of crashes.

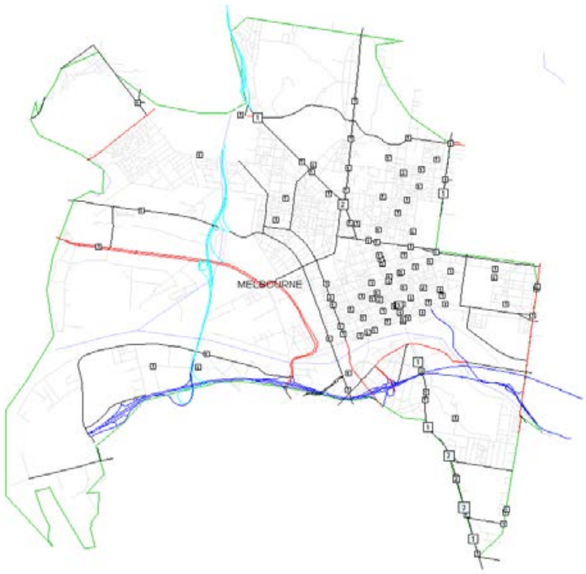


Figure 64 Map of all bike rider crashes in Melbourne (2002)

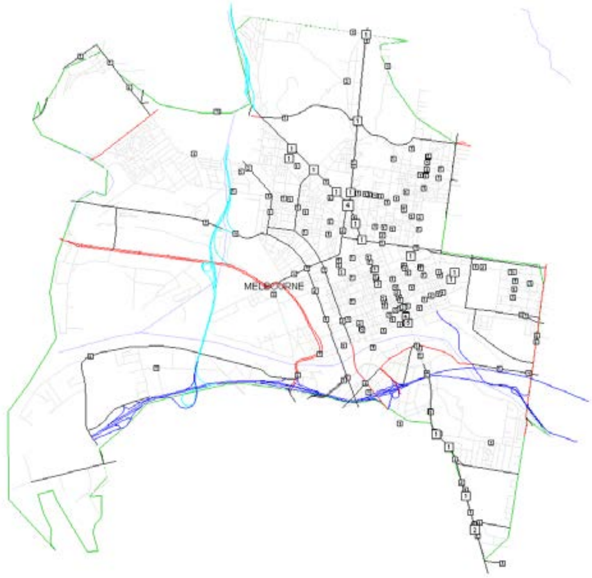


Figure 65 Map of all bike rider crashes in Melbourne (2012)

4.3.5 Municipality of Yarra

Bike rider crashes in the municipality of Yarra steadily increased over the study period. This increase is likely to be a function of the increasing number of people who are riding bikes, as the municipality of Yarra has invested extensively in cycling facilities and has one of the most extensive cycling-inclusive approaches to road design in Victoria. Figure 66 and Figure 67 map the crashes that occurred in the municipality of Yarra in 2002 and in 2012, and clearly illustrate the increase in the number of crashes.

Figure 66 Map of all bike rider crashes in Yarra (2002)

Figure 67 Map of all bike rider crashes in Yarra (2012)

4.3.6 Municipality of Port Phillip

Bike rider crashes in the municipality of Port Phillip numbered the third highest in the state. Port Phillip includes the northernmost section of Beach Road, one of the most heavily cycled routes in Victoria, particularly for sport/recreation riders in the early mornings and on weekends. Figure 68 and Figure 69 map the crashes that occurred in the municipality of Port Phillip in 2002 and in 2012.

Figure 68 Map of all bike rider crashes in Port Phillip (2002)

Figure 69 Map of all bike rider crashes in Port Phillip (2012)

4.3.7 Municipality of Moreland

Bike rider crashes steadily increased in the municipality of Moreland from 2002 to 2012. In 2002 there were 45 bike rider crashes; this had almost doubled to 84 in 2012 and is approaching the same number of bike rider crashes as in Port Phillip.

According to the Moreland City Council (2013), the number of residents riding bikes has increased, with 5–10 per cent of residents riding to work. The Moreland Council has outlined a number of projects planned in order to help make Moreland a safer location for bike riders, including the upgrading of existing bike riding paths both on and off road and installing traffic control systems to help ensure better traffic flow (Moreland City Council 2013). Over the past 10 years, crash frequency has been increasing, in particular on Sydney Road, as demonstrated in Figure 70 and Figure 71.

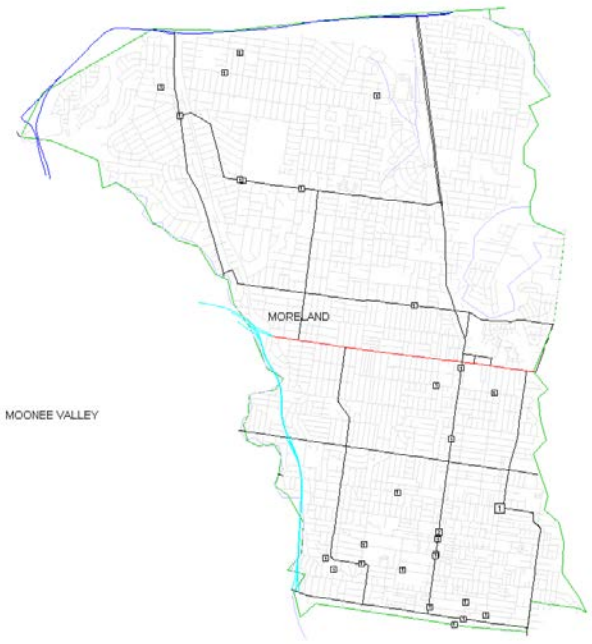


Figure 70 Map of all bike rider crashes in Moreland (2002)

Figure 71 Map of all bike rider crashes in Moreland (2012)

5 Discussion

This study has analysed the police-reported bike rider crashes in Victoria in the period from 2002 to 2012 using the publicly available CrashStats database delivered by the state road authority, VicRoads. This section of the report is a discussion of the crash data and outlines ways to improve cycling safety in Victoria.

Reminder: Crashes reported to Victoria Police are more likely to involve a motor vehicle, due to the circumstances being such that people request police attendance or report to police post-crash.

5.1 Overview of bike rider crashes

The number of bike rider crashes in Victoria steadily decreased from 1987 to 2003. However, from 2003 to 2012 the number of bike rider crashes has shown an increasing trend. Over the period of analysis, the total number of police-reported bike rider crashes in Victoria was 14,270, an average of 1296 crashes per year. Across the study period, the number of bike crashes increased by 19.7 per cent, from 1144 in 2002 to 1395 in 2012. This equates to an average annual increase in bike rider crashes in Victoria of 1.8 per cent. Annually, since 2009, over 1000 people have been involved in bike rider crashes in Victoria. It is not known if the rate of bike rider crashes has changed over that time, as accurate cycling exposure data (i.e. number of trips, frequency of trips, time cycled) are not recorded in Australia.

The number of bike rider crashes reported to police is different to that reported by Victorian hospitals, both in terms of total number of crashes (total police: 14,270; annual police: 1297; total hospital: 34,417; annual hospital: 3128).

Because not all bike rider crashes need to be reported to police and an unknown number of injured cyclists seek medical attention outside the hospital system, the total number of bike riders who are injured is unknown. This gap in the available data is an important factor in understanding bike rider safety.

What is the magnitude of bike rider crashes in Victoria?

Incompleteness of data continues to be a barrier to determining the magnitude of bike rider trauma in our community. Victorian law requires that any crash resulting in an injury must be reported to police (Victoria Police); however, for people involved in a crash that resulted in little or no property damage or minor physical injury, there can be reluctance to involve the police. Reasons that bike rider crashes are not reported to police include:

- Perception of wasting scarce resources (Amoros et al. 2006)
- Fear that reporting may result in prosecution (Amoros et al. 2006)
- Misconception that bike riders crashes are not considered road traffic crashes by the parties involved or attending authorities (Langley et al. 2003, Amoros et al. 2006)
- Misclassification of injury severity (Tsui et al. 2009).

This is an important finding in terms of the representativeness of the number of police-reported crashes. Police-reported bike rider crashes arguably contain the most comprehensively available details on the crash circumstances; however, because not all crashes need to be or are reported, there is a limitation on the types of crashes that are included in the data.

Over the study period, 2.41 times more bike rider crashes were reported to Victorian hospitals than to police. The findings and comparisons with the hospital data in this study concur with previous research that police-reported data do not include all bike rider crashes. Previous research by Andrew and colleagues (Andrew et al. 2012) in their review of sports and recreation trauma in Victoria (2001–2007) reported an increase in cycling injuries of 16 per cent per year. In an earlier review of hospital data by Sikic and colleagues (2009) for the five-year period from July 2001 to June 2006, a total of 25,920 bike riders who had crashed and presented to hospital were identified. Further, it is probable that hospital data are also an underrepresentation, given that not all bike riders who crash present to hospital.

One solution to increasing our awareness of the extent of bike rider crashes may be via an online registry. Online facilities for the public to self-report crashes are currently available in South Australia, Western Australia and the Australian Capital Territory (ACT Government 2014, Government of South Australia 2014, Insurance Commission of Western Australia and Western Australia Police 2014). This type of crowdsourced reporting option removes some of the barriers to reporting bike rider crashes, including waiting for police to attend the crash site and attending a police station. More bike riders may be likely to report crash types that are currently unreported in Victoria. It would be valuable to evaluate these facilities to establish if they do capture more data than are currently being reported to police or hospitals.

From a public policy perspective, the limitations of police-reported crashes need to be considered in both the development and evaluation of programs and initiatives to improve cycling safety. While police data provide an important part of the solution, greater information is needed.

Cycling exposure data – a critical gap

For us to have meaningful context for the number of bike rider crashes, the counterpart to having comprehensive crash data is cycling exposure data, that is, how often people ride. Lack of exposure data is the most significant gap in cycling safety research in Victoria and Australia (Sikic et al. 2009, Garrard et al. 2010) and this gap limits the usefulness of any review of crash data.

It is important to highlight the fundamental distinction between cycling ***participation*** data and cycling ***exposure*** data. What is typically reported in Australia is cycling *participation*. This is essentially the binary result of questions that can be distilled to: ‘Do you ride a bicycle?’ with yes/no responses. Question variations may include a time period (e.g. in the last week, in the last year). To date, these results do not include any measurement of cycling exposure (e.g. trip frequency, duration, distance, route choice). Without these measurements, standard indices for safety cannot be calculated. Currently in Australia, vehicle occupant (driver and passengers) fatality rates are calculated and published. For example, from 2003 to 2012, the rate of vehicle occupant fatalities decreased by an average of 3.8 per million vehicle-kilometres per year (2003: 0.79; 2012: 0.57) (BITRE 2013). Similar measurements are required for bike riders.

Comprehensive cycling exposure measurements will provide context for assessing, analysing and understanding crashes. One hypothesis is that increased bike rider bicycle rider fatality and serious injury crashes are a function of an increase in cycling activity. Put simply, the more people who ride bikes, the more people will crash. However, internationally the opposite effect has been reported. Increased cycling trips in countries including the Netherlands and Denmark have produced a ‘safety in numbers’ effect that is, the more cyclists on the road, the lower the risk of any individual bicycle rider being involved in a collision (Jacobsen 2003,

> We do not know where Victoria is positioned relative to achieving a ‘safety in numbers’ effect for bike riders.

Bonham et al. 2006, Johnson et al. 2014). We do not know where Victoria is positioned relative to achieving a 'safety in numbers' effect for bike riders.

From a public policy perspective, as for comprehensive crash data, accurate cycling exposure data are essential in order to monitor the long-term impacts of public policies, road safety messaging and investments in infrastructure in order to maximise the safety of cyclists. The federal government's target is to double cycling participation by 2016 (Austroads 2010). The context of changes to cyclists' safety is essential if governments are to be responsible about encouraging people to continue and to increase cycling.

Traditional methods of surveying, such as using Computer-Assisted Telephone Interviewing (CATI) technologies, are becoming less reliable due to falling response rates and limited demographic availability (Bracken et al. 2009). Observational counts of bike riders can be problematic due to susceptibility to overcounting (counting the same rider multiple times en route). The practice of advertising locations and dates of intended data collection by researchers may also create a sampling bias. Data collection bias (sympathetic bias) may also affect counts if the observers are part of the observed cohort and so have a vested interest in the outcomes of the study (Spano 2005).

While this analysis of bike crash data improves our understanding, its usefulness remains limited without knowing how often people ride. Knowing how often people ride would help to put bike crash statistics into context. A smart approach that uses proven methods and integrated technology is needed to creating meaningful cycling exposure data in Victoria.

5.2 Overview of bike rider crashes – police-reported

This section of the Discussion is an overview of police-reported bike rider crash data. The Safe System approach was used to structure the discussion of specific crash factors. Ways to improve cycling safety are included throughout this section.

5.2.1 Time of crash

Peak commuter travel times (8–10am and 4–6pm) were the peak times for bike rider crashes for all injury outcome crashes, and the majority of crashes occurred during the day in clear and dry conditions. These two temporal details are not unexpected, given the likelihood that many bike riders will ride during the day in favourable weather conditions.

A greater proportion of crashes occurred during the week compared to weekends. Given the high rate of crashes during peak commuter travel times, this suggests that more crashes occur during commuting or utilitarian trips compared to sport/fitness or recreational/leisure bike trips.

Bike rider crashes occurred in all months of the year, with March the single month with the most crashes (10.2%) and fewer crashes occurring in June (7.2%) and July (7.1%). January and December were the most common months associated with bike rider fatality, with 13 bike riders killed in each of these months; fatalities were least likely to occur in June, with only two reported between 2002 and 2012.

5.2.2 Crash types

The most common crash type in all bike rider crashes were crashes when travelling in the same direction. This category of crash type (DCA 130–139) includes lane side-swipe, left-turn side-swipe and rear-end crashes, and accounted for almost half of all bike rider fatality crash in Victoria and at least 20 per cent of all non-fatal crashes.

Rear-end crashes resulted in the greatest proportion of bike rider fatality crashes (26%). Details of the rear-end fatality crashes are:

- 59% rural area; 32% in metropolitan Melbourne (excluding CBD)
- 45% in speed zones of 100kph
- 86% involved a car (as opposed to another motor vehicle type)
- 91% occurred **not** at an intersection (mid-block)

This crash type also accounted for serious injury (6%) and other injury (4%) crashes.

5.2.3 Crash location

Overall, the majority of bike rider crashes occurred in metropolitan Melbourne. Bike rider crashes occurred across Victoria over the study period, with greater crash density in populated and urban areas. The municipality of Melbourne had the highest total number of crashes and this is not unexpected given the increasing number of people who are riding their bikes to and in Melbourne's CBD area. Bike rider crashes also increased in inner city suburbs when there has been a reported increase in bike trips, particularly in the municipalities of Yarra, Port Philip, Boroondara and Moreland.

Mapping the crash locations of the municipalities that have had marked increases in bike rider crashes is useful to understanding changes in crash patterns over time. However, this analysis must be contextualised with broader land use details. For example, Moreland City Council has identified congestion problems emerging on shared pathways within the region, which may contribute to the increasing number of crashes on Sydney Road, as bike riders are unable or unwilling to commute via pathways shared with pedestrians.

5.2.4 Fatalities in regional Victoria

While the majority of non-fatal bike rider crashes occurred in metropolitan Melbourne, almost half of the bike rider fatality crashes occurred in regional Victoria. Recent research in regional Victoria (Baw Baw Shire Council area) (Johnson and Le 2012, Johnson and Davey 2013) has reported that some of the cycling safety concerns in regional areas are similar to those in metropolitan areas, particularly in towns, including: parking-related driver behaviour, lack of space on the road, lack of bike lanes and opening of car doors.

However, there are also regional-specific cycling safety issues that cannot be addressed with generic metropolitan-centric strategies. For example, in regional areas, the majority of roads are high speed, typically 80kph, 100kph or 110kph. Poor road surfaces, lack of sealed road shoulders and narrow, winding roads with poor sightlines in high-speed zones often means that drivers and bike riders must share roads that are ill designed for mixed modes. Yet in country areas, these are often the only available roads for drivers and bike riders.

For bike riders in regional areas to be able to cycle safely and to access the same benefits from cycling as bike riders in metropolitan areas, action needs to be taken to address a wide range of issues, including:

- Improvements to the quality of the roads
- Increased and connected cycling facilities, including on-road lanes and off-road paths
- A review of speed limits, with particular attention to the standard of the road
- An education campaign to correct current misinformation about bicycle rider and driver rights and responsibilities
- Permanent roadside signage, particularly in relation to regularly used

commuter/recreational training cycling routes
- Greater police enforcement of dangerous driving and non-compliant bicycle rider behaviour
- A collaborative approach to road use, particularly in relation to bunch riders and commercial heavy vehicles
- Increased education for heavy-vehicle drivers about how to interact safely with vulnerable road users.

5.3 Safe System approach – Safe People

Safe People is one of the four key tenets of the Safe System approach that underpins road safety in Australia. Safe People includes education and information to inform road users, as well as compliance. Safe People factors specific to bike rider crashes are discussed in this section.

5.3.1 Gender

Across all bike rider crash types and injury outcomes, more male bike riders were involved in bike crashes than females. The high proportion of males in crashes is likely to be the result of more males cycling in Victoria and concurs with findings in previous Melbourne-based cycling research (Biegler et al. 2012). Data describing the cycling population indicated 64.3 per cent of bike riders were male (Department of Communications Information Technology and the Arts 2011). In addition, the higher proportion of male crashes may be because males ride greater distances than females or ride more regularly (O'Connor and Brown 2010). There may also be behavioural characteristics related to risk-taking behaviour that contribute to more males being involved in crashes compared to females. However, this could not be determined from the CrashStats data.

5.3.2 Age

Almost 85 per cent of police-reported bike rider crashes involved adult riders aged 18 years and older. Of the male riders who crashed, almost two thirds were aged between 18 and 49 years (64.6%). Almost two thirds of female bike riders who crashed were aged between 18 and 39 years (64.2%). In fatality bike rider crashes, the age groups with the highest proportion of deaths were 30–39 years (18%), 40–49 years (17%) and 60–69 years (17%). The majority of bike riders involved in serious injury crashes were aged 18–49 years (64%). Half the bike riders involved in other injury crashes were aged 18–39 years. These age profiles differ from the research conducted by Boufous and colleagues (2012), which reported that bike riders aged 50 years and older were twice as likely to be severely injured as compared to younger bike riders.

The low number of police-reported bike rider crashes involving children may be affected by footpath riding in Victoria, which permits children under the age of 12 years and accompanying riders to ride on footpaths. If cycling crashes involving children are more likely occur off-road (e.g. bike paths, footpaths) and not involve motor vehicles, these crashes are less likely to be reported to police.

5.3.3 Helmets

Victoria has mandatory helmet use legislation, yet a quarter of bike riders who crashed were not wearing a helmet. This level of non-helmet wearing is higher than in other Melbourne-based studies, which have reported helmet use of over 90 per cent (Johnson et al. 2011, Biegler et al. 2012). Of note are the bike rider fatality crashes: in 2004 and 2008, half of the riders who were killed were not wearing a helmet at the time of the crash. Given the small number of bike rider fatalities in any one year, it is important to interpret these figures with caution. However, across the period, these two years were among those with the highest number of bike rider fatalities in Victoria (2006: 15; 2004: 9; 2008: 9).

Across the other two injury outcome categories, serious injuries and other injuries, the proportion of helmet use increased over the study period. CrashStats does not provide detailed data on the injuries sustained, so it is not possible to investigate helmet wearing/not wearing and body region injured. However, recent studies provide support for the conclusion that helmets are protective. Biegler et al (2012) reported that almost half the bike riders who crashed sustained helmet damage due to a head strike during the crash and that head protection becomes increasingly important with increased bicycle speed. Further, Yilmaz and colleagues (2013) reported that bike riders in Victoria suffered from less serious head injuries when compared to non-helmeted Dutch bike riders who had crashed.

5.4 Safe System approach – Speed Limits

Speed limit setting is a key element for best practice approaches to road safety.

Currently in Victoria and other Australian jurisdictions, the default urban speed limit is 50kph, and many metropolitan roads and roads in regional towns have a speed limit of 60kph. Most bike riders who start their trip from home will travel through these speed zones; for some, their entire trip in their local area may be on roads that have a 50kph or 60kph speed limit.

Previous research has clearly identified that increased speed is correlated with increased injury severity in the event of a crash between a bike rider and a vehicle (Andrew et al. 2012, Biegler et al. 2012, Boufous et al. 2012). For non-occupant, physically unprotected road users, including bike riders, pedestrians and to some extent motorbike riders, the maximum speed that a crash can occur at without injury is 30kph, considerably lower than the current 50kph default urban speed limit and when compared to countries that have created a safe environment for cycling.

Figure 72 shows the approximate risk of being killed for different road users across all speeds. The green represents unprotected road users. At 50kph, 7 out of 10 unprotected road users will be killed, whereas at 30kph, 1 out of 10 will survive.

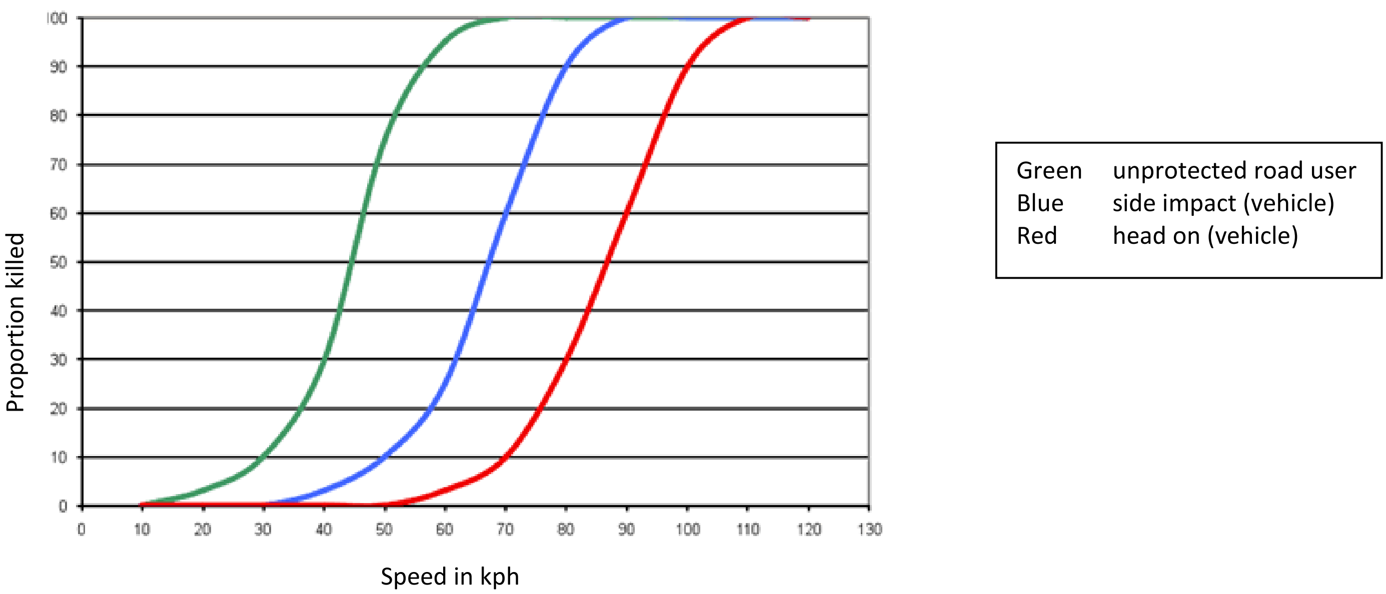


Figure 72 Approximate risk of being killed for different crash speeds and crash types (European Transport Safety Consortium 2008)

In the Netherlands, the mobility of all road users is considered in the allocation of speed limits. Local roads with a speed limit of 30kph are considered safe for bike riders and drivers to interact without any cycling-specific facilities, while roads up to 50kph require a dedicated cycle lane or separate cycle track. In speed zones of 60kph, the Dutch do combine bike riders and motor vehicles, but only if the density of motor vehicles is less than 2500 cars per day (CROW 2006).

Vehicle speed has been of central importance in the Netherlands, with the threshold for action being 60kph. 'A maximum speed of 60kph is too high to ensure optimum safety and a comfortable cycling environment. In order to do so, the speed of the motorised traffic has to be adjusted' (CROW 2006: 126).

Changes are needed to improve road safety in Victoria in relation to speed. A committed revision of the urban speed zones to reframe the public road space around our neighbourhoods is essential to improving the safety of everyone in local streets. In the road around our homes, we need to shift from spaces that maximise the speed of motor vehicle travel to spaces that are safe for active travel, including walking and cycling and use by everyone, including children.

Reducing speed zones will require community involvement to ensure that there is support for improved amenity in our neighbourhoods. Lahausse and colleagues (2010), in a study of over 4000 people in Victoria, South Australia, Western Australia and Tasmania, reported that the majority of respondents considered 50kph or 60kph speed zones to be 'about right' (71%) but proposed lower speed limits of 30kph or 40kph to be 'too low' (70%). However, other countries have faced similar community attitudes and successfully lowered speed limits. The engagement of the community may be as important as the operational process of revising street signage.

5.5 Safe System approach – Safe Roads and Roadsides

From the Safe System approach, Safe Roads and Roadsides identifies the need to design roads and roadsides to the highest safety standards possible. For many years in Australia, this safety measurement focused on vehicle occupants: drivers and passengers.

As work continues on our roads, road design remains a major contributing factor in bike rider crashes. Primarily, Victorian roads have been designed and built to maximise the safe and efficient flow of motorised vehicles, with space allocated to bike riders when available and often discontinued to prioritise motorised traffic. Action in the City of Melbourne and inner city suburbs is beginning to prioritise bike riders and reporting an increase in bike rider trips.

There are a wide range of actions that need to be taken to improve Victorian roads for bike riders. In this section, we highlight three crash types where it is evident that the road design has been a major contributing factor: intersections, vehicle doors, and emerging from lanes and driveways (drivers and bike riders) and shared paths and footpaths (bike riders).

5.5.1 Crash type – intersections

The two crash types that resulted in over 1 in 5 non-fatal crashes were Cross traffic (DCA 110) and Right through (DCA 121). Details of these crashes are:

- 100% involved a motor vehicles (98% car)
- 93% occurred at an intersection
- 81% occurred in metropolitan Melbourne

The current Austroads standard discontinues the bike lane on approach to an intersection (Levasseur 2014). This requires bike riders and drivers to somehow work out a safe approach. While this practice may be safe and intuitive when traffic is slowing towards an intersection, this configuration fails to provide any guidance to road users when negotiating the space. Typically in Victoria, intersections have no guide lines for bike riders.

Greater consideration of safe interactions of mixed road user types at intersections is needed. Models from Europe that provide a designated bike lane through intersections could offer a safer solution.

In Denmark, blue cycle crossings are installed to guide bike riders up to the stop line and then right through complex intersections. This option improves the clarity of the purpose of the road, allocates space to biker riders and reminds drivers to consider bike riders through the space (City of Copenhagen 2014). Notably, these blue cycle crossings are wide enough for bike riders to have a safe space within the bike lane from passing motor vehicles.

Figure 73 Blue cycle crossing (Denmark)

5.5.2 Crash type – vehicle doors

Almost 1 in 10 serious non-fatal crashes involved a vehicle door. One fatality dooring crash was reported during the study period. This crash type has been increasing over recent years.

Johnson and colleagues (2013) analysed this crash type in Victoria from 2000 to 2011 (police data from 2000 to 2011 and hospital data from 2000 to 2010, and naturalistic footage from 2009 to 2010) and reported that bike riders' exposure to this crash type was high, with 0.59 open door events per trip: on average, on every second trip a door was opened in front of a bike rider. On average, commuter bike riders in metropolitan Melbourne passed a parallel parked vehicle every 8 seconds and were required to be constantly vigilant to assess the potential threat of an opened vehicle door.

The major contributing factor in this crash type is the road design and the allocation of parallel parking bays in relation to on-road space for bike riders. Given that the current road design positions bike riders directly in the path of opening vehicle doors, greater resources are required to create safe vehicle-occupant behaviour. With the high rate of exposure to this risk, it is likely that bike riders develop the necessary skills to reduce their crash risk.

The practice of placing bike lanes alongside parallel parking bays needs to be revised. There are a range of options that could form a solution. Wider bike lanes that allow bike riders to avoid opening vehicles would improve safety, as would 'Copenhagen lanes' that place the bike lane between the footpath and the parked vehicles. Increased clearways, particularly along busy cycling routes, are also needed.

Drivers and passengers also must check for bike riders before opening vehicle doors. Some action was taken following the death of a bicycle rider in 2011 in Victoria, with the on-the-spot fine increased from $141 to $352 and from 1 penalty point to 2.5, and the maximum court penalty increased from $423 and 3 penalty units to $1408 and 10 penalty units. Preventative action is also needed including for example, safe door opening behaviour in road safety education in schools and as a mandatory accessible task in the new driver licensing (testing) process.

5.5.3 Crash type – emerging

Two prevalent crash types arise from bike riders and drivers emerging from driveways, lanes and paths into the pathway of other road users. That is, 16 per cent of bike rider crashes were caused by Vehicle off footpath strikes vehicle on carriageway (DCA 148) and Vehicle strikes another vehicle while emerging from driveway-lane (DCA 147). Further, over half of the child bike rider crashes reported in CrashStats from 2002 to 2012 involved being hit after emerging from a footpath or driveway.

5.6 Safe System approach – Safe Vehicles

Safe Vehicles has been an important tenet of the Safe System approach for motor vehicle occupants, with advances in vehicle technology having a significant impact on increasing safety. However, safe vehicle design for non-occupants is yet to reach the same safety gains for people outside the motor vehicle as it has for those inside.

The majority of all bike rider crashes reported to police involve a motor vehicle. As discussed above, this is likely to be a function of the minimum requirements, or the public perceptions of the minimum reporting requirements, that need to be met in order to report a crash to police. The high proportion of vehicle involvement in crashes also reinforces the low reporting of single-vehicle (bicycle-only) crashes. The majority of crashes involved passenger and small vehicles. This section focuses on two factors for safer vehicles – heavy vehicles and the bicycle, in particular bike lights.

5.6.1 Vehicles – heavy vehicles

Crashes between bike riders and heavy vehicles (including medium-sized transport and commercial vehicles and heavy vehicles) are relatively infrequent occurrences. However, over one third of bike rider fatalities involved a heavy vehicle.

Given the risk of injury severity in a crash between a heavy vehicle and bike rider, it is essential that drivers and bike riders interact safely. For drivers, it is important that training includes safe practices when sharing the roads with bike riders. For example, the approach used in the partnership between the Amy Gillett Foundation and Toll, a leading Australian logistics company, which includes information about sharing the road with bike riders. As part of the partnership, the 'a metre matters' message has been added to heavy vehicles to create a moving billboard message to other road users. Bike rider awareness training is essential for all professional drivers of large vehicles, including buses, coaches, delivery vans etc. Building on this partnership, AGF and Toll joined with Volvo Trucks to create a video illustrating how heavy vehicles and bike riders could share roads safely.

Bike riders also need to take greater care when sharing the road with heavy vehicles and large vehicles. Safe interaction with heavy vehicles is a message that has been extensively developed in the UK and lessons could be adopted for Victoria.

5.6.2 Vehicles – bicycle: bike lights

Over a third of bike rider fatality crashes occurred at night or in low light conditions. It was not possible from the CrashStats data to determine whether the bike riders' visibility was a factor in these crashes. However, of the bike rider fatality crashes that occurred in dark light conditions, over half occurred where the street lights were off or there were no street lights. Previous research has identified that riding at night, especially in areas that are unlit or have poor lighting increases the risk of injury severity in bike rider-motor vehicle crashes (Boufous et al. 2012). Further, there is an increased likelihood of alcohol and potentially illicit drug use by the bike rider or the driver at night that may be a contributing factor in the crash.

In Victoria, bike lights must be fitted to bicycles by law. Bike lights are essential for riding in low light and at night but the use of bike lights could not be determined from the CrashStats data.

Bike lights law
- flashing or steady
- visible for at least 200m
- front: white; rear: red

Also, red reflector visible for at least 50m (when reflecting low beam vehicle headlights)

Using bike lights is a critical action cyclists must take to improve their visibility to other road users. In addition to the use of bike lights being legally required, this action is also about mutual respect between bike riders and other road users. A bike rider at night can be virtually invisible to others on the road and increases the risk that drivers would not see, and could potentially hit, a bike rider on a bike without adequate lighting.

Use of adequate bike lights at night and in low light conditions is part of the Amy Gillett Foundation's *It's a 2 way street* campaign and the education and awareness of the requirements for bike lights would be addressed in a statewide campaign.

5.7 Electric bikes – the next generation

An emerging vehicle type in the bicycle fleet that requires a separate mention is electric bikes. Electric bikes are legally recognised as bicycles in Australia and riders are subject to the same road rules and permitted to ride their ebike as if it were a pedal bike. In 2012, the Australian Government adopted the European Union design standard for electric bikes, which included increasing the power output from 200 watts to 250 watts. This change has dramatically expanded the ebike models available for legal sale in Australia. While currently ebike sales figures for Australia are not collected or published, ebike retailers are reporting unprecedented and increasing demand and cannot import ebikes fast enough to meet demand (Dolomiti Electric Bicycles 2014).

Currently the official crash data reported in both police and hospital data do not include details of the bike type. This gap needs to be addressed, given the significant increases in sales and use of electric bikes and the differences in crash characteristics between ebikes and pedal bikes.

Prior to the policy change, ebikes were frequently sold with a handlegrip throttle that engaged the pedals without the rider needing to pedal. In adopting the EU standard, the power assistance can only be engaged by pedalling, also called pedal assist or pedelec (Australian Government 2012, Rose 2012). These models are still part of the existing Australian ebike fleet and are reported to be a crash-contributing factor (Johnson and Rose 2014).

Early research on the use of electric bikes In Australia has reported that people who were infrequent bike riders reported that their ebike is integrated into daily travel, often replacing the car (Johnson and Rose 2013). While there are definitely gains in shifting people from their sedentary motor car to active transport (Simons et al. 2009, Gojanovic et al. 2011), there are also new ebike-specific safety concerns.

With a wider range of people with different levels of skills and experience now choosing to ride an electric bike, there may be an increase in bike crashes from ebike riders with crash profiles that are distinctly different from those of pedal bike crashes (Johnson and Rose 2013). Crashes that involve ebikes must be clearly identified in the reported crash data to ensure accurate monitoring of ebike crashes, as distinct from pedal bike crashes, over time. This will ensure the magnitude of ebike related crashes can be accurately determined and provide evidence should ebike-specific countermeasures be required to improve safety outcomes.

6 Conclusion

This study demonstrates that analysis of bike rider crashes is an important component to understanding how to create a safe cycling environment. It clearly shows that there are distinct differences in the crash profiles of fatal bike rider crashes compared to non-fatal crashes. The highest proportion of bike rider crashes are occurring in urban areas, mainly metropolitan Melbourne. However, almost half of all bike rider fatality crashes in Victoria occur in regional areas. Rear-end crashes with the vehicles travelling in the same direction are the crash type which results in the greatest proportion of bike rider fatality crashes. Crashes are more likely to occur at non-intersections and heavy vehicles are involved in over one third of crashes. While it is important to take action to improve the safety of the circumstances that result in fatality crashes, it is also important to recognise the enormous number of people who are injured in non-fatal crashes.

In this report, factors that contributed to bike rider crashes reported in CrashStats have been highlighted and some potential countermeasures highlighted.

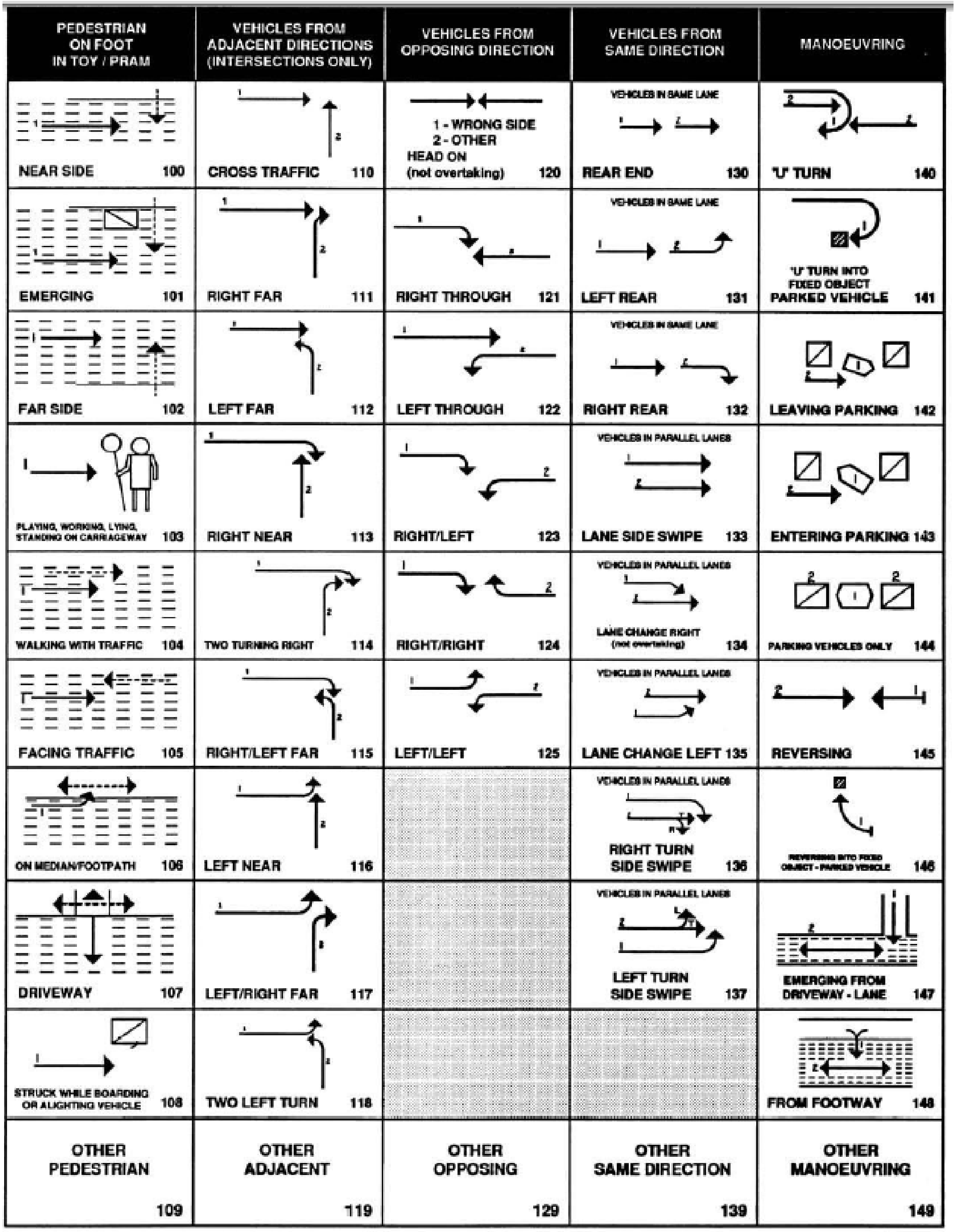
However, as shown, the insight offered by crash data analysis alone is limited and it requires comprehensive data about cycling trips to understand how changes in participation affect crash rates. Further, it is important to acknowledge that while police data provide one of the most comprehensive data sources about road user crashes, there are important limitations that need to be considered.

Further research to fill these gaps and address these limitations includes:

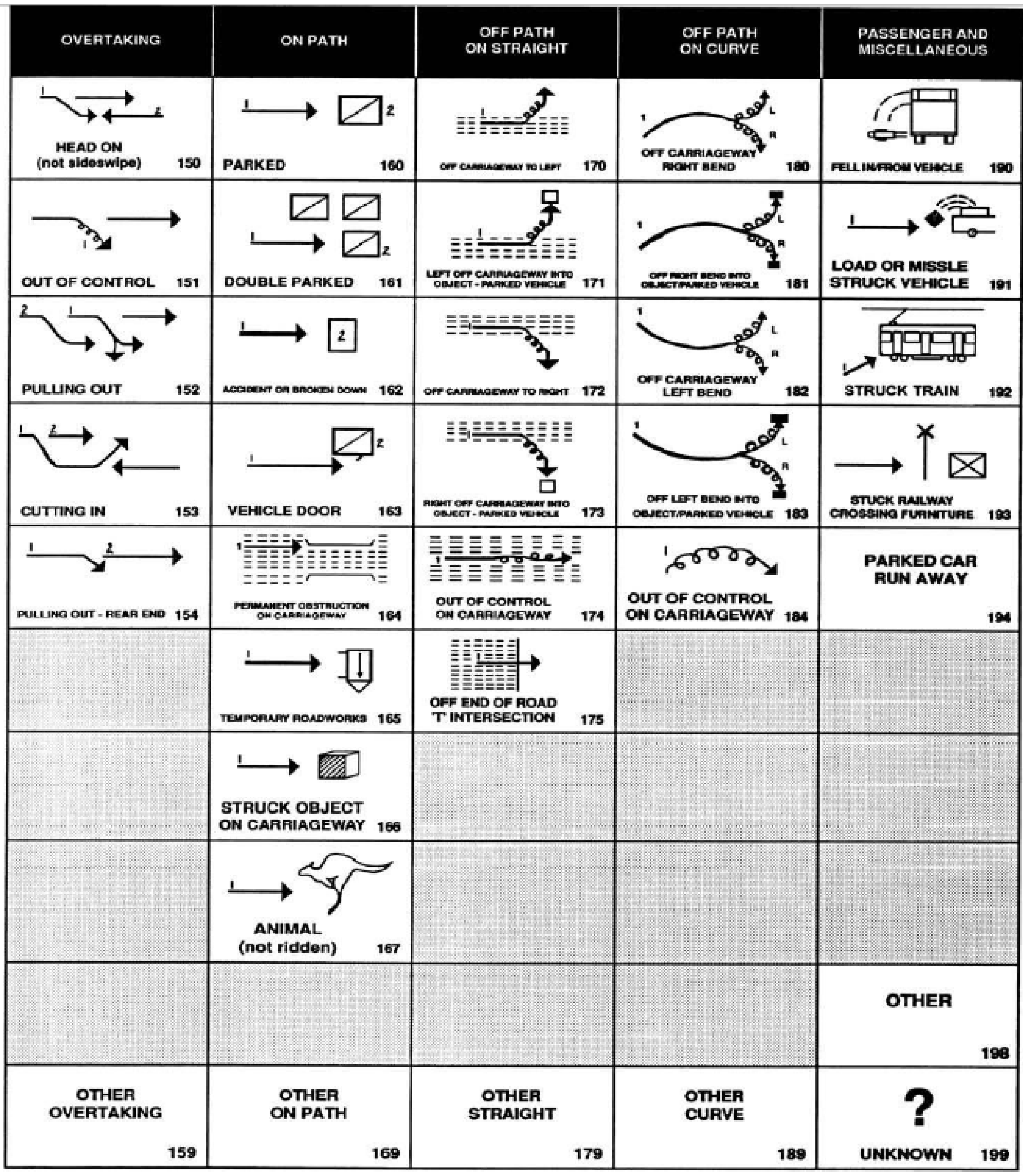
- Evaluate online crash self-reporting systems in other jurisdictions and compare with data reported to police and hospitals to determine the value of generating a similar online system in Victoria
- Research to identify the most effective questions to include in driver licence written test and on-road skills training and tests; and
- Review international best practice for generating cycling exposure data to develop a robust cycling exposure measurement.

7 Appendix

Source: VicRoads (2008)



1. Definition for classifying accidents (DCA) should be determined by first selecting a column using the text above & then by diagrammatic sub-division.
2. The sub-division chosen should describe the general movement of vehicles involved in the initial event. It does not assign a cause to the accident.
3. Supplementary codes have been defined for most sub-divisions. These codes give further detail of the initial event.



4. The number 1,2 identify individual vehicles involved when the DCA is linked with other vehicle/driver information.
5. These codes were used for 1987 accidents and replace the Road User Movement (RUM) code.

Produced by the Road User Behaviour Branch, Road Safety Division, VIC ROADS - DCA.pm4 & DCA2.pm4

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