MONASH University

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE

HAZARD

Edition No. 87 | April 2020

ADULT ON-ROAD CYCLIST INJURY IN VICTORIA, 2008/09 TO 2017/18:

A REPORT ON AMBULANCE ATTENDANCES, EMERGENCY DEPARTMENT PRESENTATIONS, HOSPITAL ADMISSIONS AND DEATHS

Hazard | Edition No. 87 | April 2020
Victorian Injury Surveillance Unit (VISU)
www.monash.edu/muarc/visu
Monash University Accident Research Centre (MUARC)

ADULT ON-ROAD CYCLIST INJURY IN VICTORIA, 2008/09 TO 2017/18:

A REPORT ON AMBULANCE ATTENDANCES, EMERGENCY DEPARTMENT PRESENTATIONS, HOSPITAL ADMISSIONS AND DEATHS

This edition of *Hazard* focused on adult (persons 15 years and over) on-road cyclist injury in Victoria. A recent national AIHW report indicated that rates of injury and death among on-road cyclists in this age group have risen significantly in the last six years (AIHW 2019). Over the last 20 years, the age composition of cyclists has also changed: in 1999/00, 48% of people injured in cycling crashes were aged between 5-14 years, compared to 20% in 2015/16, while the proportion in the 25-44 year age group increased from 18% to 31%, and the 45-64 year age group from 7% to 26%.

This *Hazard* issue includes placed-based injury information. This is of particular interest for injurious activities that are likely to occur in locations outside the injured person's residential area. This place-based information is used to geographically map cyclist injury rates across Victoria and across the Melbourne metropolitan area in particular. For this specific purpose, we have requested data from Ambulance Victoria, which contains information on the ambulance call-out location.

The aim of this edition of Hazard is to provide an in-depth description of on-road cyclist injury in Victoria for the most recent three years of available data (2015/16-2017/18) and an overview of 10-year trends (2008/09-2017/18) among persons aged 15 years and over, in terms of ambulance attendances, ED presentations and hospital admissions. An overview of on-road cycling-related fatalities is also provided, for 2007 to 2017, Victoria.

The data sources for this report are: ambulance attendance data provided by Ambulance Victoria; and VISU-held injury surveillance datasets which include the Victorian Emergency Minimum Dataset (VEMD), the Victorian Admitted Episodes Dataset (VAED), and the Cause of Death Unit Record Dataset (COD). Population data was sourced from the Australian Bureau of Statistics (ABS).

Authors:
Steve O'Hern (MUARC)
Voula Stathakis, Janneke Berecki, Tharanga Fernando, Jane Hayman, Angela Clapperton (VISU)
Brendan Lawrence (MUARC)
Karen Smith, Shelley Cox (Ambulance Victoria)

CONTENTS

Overview

Executive Summary 3

Introduction 6
- Aim 8
- Sources 8

Results 9
- Overview of Methods Used to Determine Patterns of Adult On-Road Cyclist Injury 9
  - Case Selection for Ambulance Attendance Data 9
  - Case Selection for Emergency Department Presentations 9
  - Case Selection for Hospital Admissions Data 9
  - Case Selection Ffor Death Data 9

Section A: Cyclist Injury Deaths 11
- Adult On-Road Cyclist Deaths: 2007 to 2017, Victoria 11

Section B: Cyclist Injuries (3 Years) 15
- Adult On-Road Cyclist Injury: 2015/16 to 2017/18, Victoria 15
  - Ambulance Attendances 15
  - Emergency Department Presentations 20
  - Hospital Admissions 24
- Burden of On-Road Cyclist Injury: 2015/16 – 2017/18 (Three Years). 31
  - Length of Stay 31
  - Hospital Costs 34
- Place of Occurrence 34
- Helmet Use 46
- Cyclist Group Riding 46
- Male Cyclists Aged 45+Yrs 46
  - Injury Location Hotspots 46
  - Day of Injury 47
  - Injury Type 47
  - Cause of Injury 48
  - Circumstances and Setting 48

Section C: Cyclist Injury Trends (10 Years) 50
- Ten-Year Trends in Adult On-Road Cyclist Injury (2008/09-2017/18) 50
  - Ambulance Attendances 50
  - Emergency Department Presentations 52
  - Hospital Admissions 54

Discussion 59
- Main Findings from the Most Recent Three Years 59
- Main Findings About Trends Over the Past 10 Years 61
- Findings Within the Context of Current Policy Responses and Policy Implications 63
- Limitations 63
  - Limited Data Sources 63
  - Sport or Transport? 63
  - Place of Injury Occurrence 63
  - Increasing Popularity of Bicycle Riding In Victoria 63
- Recommendations 64
  - Policy and Infrastructure Investment Recommendations to Government 64
  - Education 64
  - Bicycle Research Investment 65
  - Injury Surveillance and Coding 65

References 66

Appendix A: Data Sources and Case Selection 69
- Cause of Death Data 69
- Hospital Admissions 69
- Emergency Department Presentations 70
  - VEMD Case Selection Based on Text Searches 70
  - VEMD Case Selection Based on NMDS Codes 70
- Ambulance Attendance Data 71

Appendix B: Statistical Analysis 72

Appendix C Overnight Stay Hospital Admission Trends 73

Appendix D ‘Urgent’ ED Presentation Trends 74

Hazard Edition Index 75

EXECUTIVE SUMMARY

In Victoria, bicycle riding is popular as a form of recreation as well as a mode of transport. This is to be encouraged, in light of population health, environmental impact, and reducing traffic congestion in a time of rapid population growth and urbanisation in Victoria. Safety, however, is a concern: in Victoria, bicycle riders are considered one of the most physically vulnerable road users. In order to address cyclist safety, data is needed on the injury profile of bicycle riders. Data sources for this should not be limited to police and injury compensation data, which capture only a small proportion of all cyclist injuries.

The aim of this edition of Hazard is to provide an in-depth description of on-road cyclist injury in Victoria, among adults aged 15 years and above. Ten-year trends and injury patterns in the most recent three years are presented, based on Ambulance Victoria data, emergency department presentations recorded in the Victorian Emergency Minimum Dataset (VEMD), hospital admissions recorded in the Victorian Admitted Episodes Dataset (VAED). In addition, cyclist fatalities recorded in the Cause of Death Unit Record Dataset (COD) in 2007 to 2017 are presented.

Fatalities

- In the 11-year period from 2007 to 2017, 82 Victorian cyclists aged 15 years and over died in on-road cycling-related crashes: an annual average of approximately 7.5 deaths per year.
- The majority were males, accounting for 90% of deaths. The average age at death for males was 53 years while the average age at death for females was 42 years.
- A large proportion (39%) of on-road fatalities were due to the cyclist colliding with cars, pick-up trucks or vans, followed by collisions with heavy transport vehicles or buses (22%). Non-collision transport fatalities accounted for 21%.

Patterns – 3 years:

Ambulance Attendances

- In the three-year period from 2015/16 to 2017/18, there were 4960 ambulance attendances for on-road cyclist injury cases among Victorian adults.
- Persons aged 25-34 years made up almost a quarter of all cases; the wider age group 25-44 years accounted 43% of cases. Three-quarters of all cases (74%) were male.
- A vehicle was noted in 64% of adult on-road cyclist injury ambulance attendance records with 37% involving a car or equivalent (e.g., utility vehicle, 4WD or SUV, taxi).
- The most commonly recorded injury types were: laceration (22%), bruising/haematoma (22%) and fracture (21%).

Emergency Department Presentations

- In the three-year period from 2015/16 to 2017/18, there were 9640 ED presentations for on-road cyclist injury cases among Victorian adults.
- One-quarter of cases were persons aged 25-34 years; the wider age group 25-44 years accounted for close to half of all cases (46%). Three-quarters of all cases were male.
- Common injuries were bone fractures (33%), dislocation, sprain & strains (17%) and superficial injuries (13%). Body region injured was most commonly the upper extremity (43%), head/face/neck (17%) and lower extremity (16%).
- 31% of those presenting to the ED were admitted to hospital for further treatment.

Hospital Admissions

- From 2015/16 to 2017/18, there were 6301 hospital admissions related to on-road cyclist injury in adults in Victoria.
- The 10-year age group with the greatest proportion of cyclist injury admissions was 25-34 years with 22% of adult admissions; 61% were aged between 25 and 54 years. Over three-quarters of all cyclist injury admissions were male (77%).
- Non-collision transport accidents were the most commonly recorded cause of cyclist injury admissions (44%). Among recorded collisions, collision with a car, pick-up or van was the most common (24%), followed by collision with another pedal cycle (6%); collision with pedestrian (or animal) was relatively uncommon (1.5%).
- Common injury types were bone fractures (57%), open wounds (10%) and superficial injuries (8%). Body region injured was most commonly the upper extremity (43%), head/face/neck (25%) and lower extremity (16%).

Burden of Injury

- In Victoria for the years 2015/16 to 2017/18, hospital beds were occupied for 19,953 days as a result of adult on-road cyclist injury. More than three-quarters (76.6%, n=15,288) of total bed days were accounted for by males.
- Overall, 46% of bed days were attributed to collision bicycle crashes, 38% to non-collision bicycle crashes and 15% to *other and unspecified* bicycle crashes.
- In the three-year period 2015/16 to 2017/18, there was an estimated $41.3m AUD in hospital admission costs for adult on-road cyclist injury. More than three-quarters (79%) was accounted for by males and a slightly smaller proportion was accounted for by persons aged 25-64 years (73%).

Place of Occurrence and Area of Residence

- In this edition of Hazard, for 2015/16 to 2017/18, Victoria, overviews of the number of ambulance attendances for each LGA by the *call-out location* for adult on-road cyclist injury are provided. The highest number of ambulance attendances were in the City of Melbourne (n=1,014), Bayside City Council (n=263), Darebin City Council (n=252) and the City of Greater Geelong (n=178).
- Considering the injured person's *area of residence*, the greatest number of ambulance attendances were for injured cyclists residing in the City of Melbourne (n=570), the City of Boroondara (n=464) and Frankston City Council (n=430).
- Area of residence of injured cyclists presenting to the ED in 2015/16 to 2017/18 are also presented: most common were persons residing in the City of Melbourne (n=483), Moreland City Council (n=745) and the City of Darebin (n=561).
- Area of residence of injured cyclists admitted to hospital in 2015/16 to 2017/18 are also presented: most common were from residents of Moreland City Council (n=385), the City of Port Phillip (n=374) and Darebin City Council (n=307).

Helmet Use

- Ambulance data included variables relating to helmet use, although this data is not mandatory for paramedics to record. Helmet related information in this category was available for 33% of cases.
- In these 1627 cases, a helmet was recorded as "Worn – in situ" or "Worn – Removed" for 92.5% (n=1505) of these cyclists, with a further 2% recorded as "Not worn" and in an even smaller proportion it was recorded as not known (1.3%).

Group Riding

- Group or bunch riding incidents were identified in ambulance attendance data via text search: this was recorded in 136 records (3% of ambulance attendances).
- Males accounted for 83% of cyclists riding in groups while those aged 45+ years represented 70%.
- Almost two-thirds (65%) of ambulance attendances related to injured cyclists riding in groups occurred in the Melbourne Metropolitan area.

Male Cyclists Aged 45+ Years

- In Victoria from 2015/16 to 2017/18, male cyclists aged 45 years and above accounted for 1634/4960 (33%) of on-road adult cycling ambulance attendances, 2621/9640 (27%) of ED presentations and 2178/6301 (35%) of hospital admissions.
- Almost three-quarters (73%) of ambulance attendances for this demographic occurred in Melbourne Metropolitan areas.
- There were no marked differences between injury cause among males aged 45+ years and other cyclists: most common in both groups were non-collision transport accidents (45% and 44%) followed by collision with car, pick-up truck or van (23% vs. 25%).
- Serious injuries were relatively common; in comparison to all adult on-road cycling injuries, bone fractures (61% vs. 54%) and intracranial injuries (7.2% vs. 5.6%) were overrepresented in this demographic.

Trends – 10 years

In the ten-year period from 2008/9 to 2017/18, there were 14,546 ambulance attendances, 32,015 Emergency Department presentations and 17,496 hospital admissions in relation to on-road cyclist injury in Victoria.

Ambulance Attendances

- The average age-standardised rate of ambulance attendances for cyclist injury in the ten-year period was 31 per 100,000 population.
- The ambulance attendance rate increased statistically significantly by 2.0% per year.

Emergency Department Presentations

- The average age-standardised rate of ED presentations for cyclist injury in the ten-year period was 69 per 100,000 population.
- The ED presentation rate decreased statistically significantly by -1.4% per year. ED presentation rates, however, could be influenced by external factors such as initiatives to prevent overcrowding in emergency departments. Selecting only ED presentations triaged as urgent showed an increase in cycling injury rates during the 10-year period.

Hospital Admissions

- The average age-standardised rate of hospital admissions for cyclist injury in the ten-year period was 37 per 100,000 population.
- The hospital admissions rate increased statistically significantly by 3.4% per year. These rate changes may have been influenced by the Victorian hospital admission change in 2012. *Overnight hospital admission* rates, which are less sensitive to the policy change, increased by 2.9% per year during the 10-year period.

INTRODUCTION

Riding a bicycle is a popular form of recreation and mode of transportation. In Victoria, The National Cycling Participation Survey estimates that 2.3 million people, approximately 35.4% of the population, cycled at least once in the past year (Austroads, 2019). With the rate of participation decreasing slightly for the past decade, there is significant scope to increase the number of trips made using bicycles, as recognised in the current Victorian strategy: *Victorian Cycling Strategy 2018-2028 – Increasing cycling for transport* (Transport for Victoria, 2017) and the *Victorian public health and wellbeing plan 2019-2023* (Department of Health and Human Services, 2019).

One of the motivations for increasing the number of trips made using bicycles is the rapid population growth and urbanisation occurring in Victoria, a phenomenon being experienced through many parts of the world (WHO, 2007). By 2051, it is expected that over 10 million people will live in Victoria, and over 8 million people will live in metropolitan Melbourne (Transport for Victoria, 2017). Increased population and urbanisation are a by-product of human development and improvements in health. However, they also represent challenges for urban areas (WHO, 2007). Forecasts suggest that by 2050, Melbourne's transport network will need to accommodate an extra 10 million trips per day (Transport for Victoria, 2017). The increased demand on the transportation network will exacerbate congestion, requiring people to adopt different patterns of mobility and reduce their reliance on private motor vehicle travel.

Riding a bicycle offers a viable alternative to private motor vehicle travel, particularly in Melbourne, where more than half of all vehicle trips are under six kilometres (Transport for Victoria, 2017). Alongside the ability to reduce congestion, riding a bicycle is considered a panacea for many of society's modern issues (Bauman, A. et al., 2011; Dickinson et al., 2011) and is associated with a diverse range of social, environmental, economic and health benefits, both for the individual and for the broader community (Bauman, A. et al., 2008; Garrard, 2009; Handy et al., 2014; Stevenson, Mark et al., 2016).

While the benefits of riding a bicycle are well established, it is not without risk, with bicycle riders considered to be one of the most physically vulnerable road user groups due to their limited protection and low tolerance to the forces associated with collisions, especially when motor vehicles are involved (Chong et al., 2010; Mindell et al., 2012; Stevenson, M. et al., 2015).

In this edition of Hazard we identify that in Victoria, using the past ten years of available data, there have been at least:

- 76 deaths involving people riding bicycles
- 14,546 ambulance attendances
- 32,105 Emergency Department presentations
- 17,946 hospital admissions

Furthermore, time trends indicate an increase in the rate of injuries over the ten year period. These figures are concerning, especially given the overall reduction in the number of serious and fatal injuries for car occupants over the past few decades in Victoria, with estimates suggesting that the relative risk of injury for cyclists is between 13 and 34 times greater per kilometre travelled, compared to car occupants (Garrard, J et al., 2010).

The risk associated with riding a bicycle on-road and principally the associated risk of being hit by a motor vehicle have been found to be key deterrents to participation (Daley et al., 2007; Garrard, Jan et al., 2006), particularly amongst less experienced bicycle riders and people with lower tolerance to risk. Research suggests that in order to facilitate growth in participation there is a need to address safety issues (Fishman et al., 2012), especially for on-road cycling (Bauman, A. et al., 2008; Fishman et al., 2012; Garrard, 2009; Garrard, J et al., 2010) and roads with higher traffic volumes and vehicular speeds (Heesch, Kristiann C et al., 2012b; Winters et al., 2011).

Consistently, research from Victoria has demonstrated that the risk of injury for on-road bicycle riders increases with the speed environment (for example, Boufous et al. (2012) and Morrison et al. (2019)). Reflecting the limited biomechanical tolerance of bicycle riders when involved in high speed collisions, this demonstrates a need for dedicated cycling infrastructure to reduce bicycle rider and motor vehicle interaction. Other built environment factors associated with increased risk include roundabouts, tram lines and arterial shopping centres (Morrison et al., 2019; O'Hern & Oxley, 2018), while bicycle lanes (particularly separated bicycle lanes (Morrison et al., 2019)) have been found to have a preventative effect.

When considering bicycle rider demographics, injuries are more commonly associated with males and older bicycle riders. Two reasons for the over-representation of males are that, in Australia, more males typically ride bicycles compared to females (O'Hern & Oxley, 2015; Transport for Victoria, 2017), while males also have a greater propensity for risk taking behaviours (Cobey et al., 2013). Physical frailty of older persons may contribute to the over representation of serious injuries among older cyclists (Boufous et al., 2013). However, the demographic profile may also reflect the increasing trend of people participating in cycling as a form of recreation and transport in middle age, colloquially referred to as Middle Aged Men in Lycra or MAMILs (Bauman, A. E. et al., 2018).

Bicycle and rider equipment can also influence crash involvement and injury outcomes. Mechanical issues including gears jamming, chains falling off and brake failure have all been identified as contributing factors in bicycle crashes (Shaw et al., 2012). Injury statistics also reveal increased odds ratios of injury involvement for people not wearing helmets (Boufous et al., 2012; Macpherson & Spinks, 2008). This may also reflect the increased risk profile of those who choose not to wear helmets. Furthermore, there is still ongoing debate as to whether mandatory helmet laws act as a potential barrier to participation (Macpherson & Spinks, 2008).

The activities that people engage in while riding bicycles influence collision mechanisms. Recent research from Western Australia identified that people engaged in group riding experience a range of different crash types compared to individual riders (Fraser, 2019). Victorian research also demonstrates that locations popular with group riding have higher crash rates for bicycle riders (Lawrence et al., 2015). Cyclists also experience a high proportion of injury when no other road users are involved; these injuries are more likely to occur in the dark, in wet conditions and in rural areas and commonly involve loss of control of the bicycle (Boufous et al., 2013). There is evidence to suggest that alcohol, licit and illicit substances and engaging in distracting tasks are also contributing factors (Airaksinen et al., 2018; Useche et al., 2018).

Notwithstanding the risk, research has consistently demonstrated that they are outweighed by the benefits of riding a bicycle (De Hartog et al., 2010; Hillman & Morgan, 1992; Woodcock et al., 2009). Furthermore, it has been established that as the number of people riding bicycles increase, the population risk decrease. In particular this is evidenced by the substantially lower cyclist injury rates in the Netherlands and Denmark, two nations with high levels of cycling participation (Pucher & Buehler, 2008b).

The high levels of bicycle use in the Netherlands and Denmark are often attributed to the high proportion of separated cycling infrastructure in urban locations where bicycle riders and motor vehicles interact, education programs for bicycle riders and motor vehicle drivers and driver licencing and road safety systems that place a great responsibility for safety on motor vehicle drivers (Pucher, John & Buehler, 2008). Apart from government commitments to develop cycling infrastructure, another key reason for high levels of cycling mode share in European cities is the compact land-use pattern (Stevenson, Mark et al., 2016). Other design factors that influence increased cycling participation in Europe include the provision of traffic calming measures to lower vehicle speeds, provision of end-trip facilities, and integrating cycling with public transport (Martens, 2007).

Globally, there are also a range of mega-cities that are seeing a resurgence in cycling, including London, Tokyo, and New York. The resurgence is driven by investment in infrastructure and implementation of cycling-friendly policies. These international examples demonstrate how cycling can grow within some of the largest cities of the world, that currently have populations comparable to forecasts for Melbourne in 2050. However, while it is recognised that there are many positives to be gained from increased cycling participation, there is a need to ensure that cycling can be undertaken safely and that increases in participation do not result in a disproportionate increase in trauma.

WHILE THE BENEFITS OF RIDING A BICYCLE ARE WELL ESTABLISHED, IT IS NOT WITHOUT RISK, WITH BICYCLE RIDERS CONSIDERED TO BE ONE OF THE MOST PHYSICALLY VULNERABLE ROAD USER GROUPS.

Aim

The aim of this edition of Hazard is to provide an in-depth description of on-road cyclist injury in Victoria for the most recent three years of available data and an overview of 10-year injury trends in adults aged 15 years and over, in terms of ambulance attendances, ED presentations, hospital admissions and deaths. 'On-road' refers to injury incidents occurring in traffic on public roads and streets including on-road bicycle lanes.

Additional aims are to provide insight into:

1. Age and sex specific injury profiles and time trends
2. Mapping of cycling injuries by location of the injury event and cyclist area of residence
3. Day and season of cyclist injury
4. Conditions relevant to cycling safety, such as 'group riding', helmet use, injury circumstance and setting
5. Cycling injury burden in terms of hospital cost and length of hospital stay

By developing a holistic understanding of the current levels of trauma experienced by people riding bicycles, key road safety issues can be identified for bicycle riders and the findings can inform policy, legislation and the development of infrastructure needed to grow participation while reducing the burden of injury.

Sources

The data sources for this edition of Hazard are Ambulance Victoria Data, the Victorian Emergency Minimum Dataset (VEMD), the Victorian Admitted Episodes Dataset (VAED), and Cause of Death Unit Record Data (COD). Population data were sourced from the Australian Bureau of Statistics (ABS).

RESULTS

Section A analyses adult on-road cyclist deaths for all years of available Cause of Death data. **Section B** is a detailed examination of adult bicycle injuries from the past three years, in terms of various demographic and clinical details. **Section C** is a broad examination of adult bicycle injury trends over the past 10 years.

OVERVIEW OF METHODS USED TO DETERMINE PATTERNS OF ADULT ON-ROAD CYCLIST INJURY

For the correct interpretation of the presented ambulance attendance, emergency department presentation, hospital admission and death data statistics, an understanding of the case selection for each data source is essential.

Case Selection for Ambulance Attendance Data

Ambulance attendance cases were provided by Ambulance Victoria (AV). AV data is based on data collected by paramedics at the point of care in the field, recorded on an electronic tablet utilising Victorian Ambulance Clinical Information System (VACIS) application software and synchronised to AV's data warehouse. This dataset is largely text based with limited coding compared to established VISU datasets. Ambulance Victoria identified records for this edition of Hazard by selecting "Case Nature" variable codes representing "Trauma: Bicycle" and "Bicycle Collision" incidents. The "Scene Location type" variable provided by Ambulance Victoria was used in combination with an extensive list of included on-road and excluded off-road cycling terms within the case narrative text to select adult on-road cyclist-related ambulance attendance cases for analysis. Further details about case selection are provided in Appendix A.

Case Selection for Emergency Department Presentations

Emergency Department cases were selected from the Victorian Emergency Minimum Dataset (VEMD) which records all presentations to Victorian public hospitals with 24-hour emergency departments (currently 38 hospitals). On-road cyclist-related injury presentations were identified using two methods:

(1) Via a text search of the case narrative in the VEMD to identify cases of bicycle-related injury. Search terms for example included: bicycle, bike, cycle etc. Identified cases were manually checked for relevance

(2) Additional cases were selected using the injury surveillance codes in the VEMD: cases with an injury cause coded as a "pedal cyclist - rider or passenger" (code="5")

Cases were limited to those occurring 'on-road' using the 'place where injury occurred' field from the injury surveillance codes. Further details about case selection are provided in Appendix A.

Case Selection for Hospital Admissions Data

Hospital admission cases were selected from the Victorian Admitted Episodes Dataset (VAED) if the ICD10-AM external cause was coded as 'pedal cyclist injured in transport accident' (ICD10-AM range 'V10' to 'V1999') and the collision took place 'on road'. The ICD10-AM codes indicated if the injured cyclist was a 'rider', 'passenger' or 'unspecified pedal cyclist' and also described the collision partner (See Appendix A, Table 1A for further information about ICD10-AM codes).

The exact matching of ED presentations records to admissions could be achieved through a data linkage study. This is, however, outside the scope of this edition of Hazard.

Case Selection for Death Data

Data were extracted from the VISU-held Cause of Death (COD) dataset supplied by the Australian Coordinating Registry (ACR) and based on the Australian Bureau of Statistics (ABS) cause of death data. Adult on-road cyclist deaths were selected using ICD-10 underlying cause of death (UCoD) codes in the range of V10-V19 (pedal cyclist injured in transport accident) restricted to external cause sub-codes 4-6 or 9 (pedal cycle driver, passenger or cyclist of unspecified type involved in "traffic" or "on-road"). Case selection was limited to deaths registered over the 11-year period ranging from January 2007 to December 2017.

SECTION A:

CYCLIST INJURY DEATHS

ADULT ON-ROAD CYCLIST DEATHS: 2007 TO 2017, VICTORIA

Over the 11-year period from 2007 to 2017, a total of 98 Victorian cyclists aged 15 years and over died in cycling-related crashes. On-road (traffic) fatalities accounted for 84% (n=82) of all adult cycling-related deaths (n=98) during this period, representing an annual average of approximately 7.5 deaths per year. Table 1 provides an overview of the frequency of on-road cyclist deaths over the study period. Numbers fluctuated over time with some peaks recorded in 2011 (n=10) and 2015 (n=15).

Table 1

Victorian Adult On-Road Cyclist Deaths, 2007-2017

Year	Deaths (N)	%
2007	6	7
2008	*	*
2009	7	9
2010	*	*
2011	10	12
2012	7	9
2013	*	*
2014	8	10
2015	15	18
2016	6	7
2017	9	11
Total	**82**	**100**

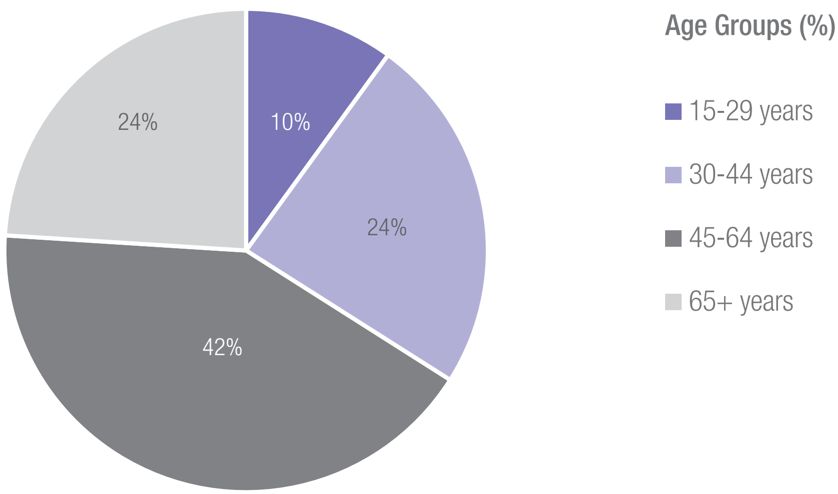
*Cases have been suppressed due to small cell counts.

Gender differences were significantly skewed towards males, accounting for 90% (n=74) of all deaths over the 11-year study period. The average age at death for males was 53 years (95%CI 49, 57) and ranged from 16 to 80 years of age, while the average age at time of death for females was 42 years (95%CI 31, 53) and ranged from 28 to 63 years of age.

Fatally injured cyclists were stratified by broad age groups and described in Figure 1 below. The peak affected age group were to on-road cyclists aged 45-64 years, representing 42% (n=34), followed by 30-44 and 65+ age groups, each equally representing 24% (n=20) of cyclist deaths. The youngest group (15-29 years) accounted for 10% (n=8) of cyclist deaths over the 11-year period. To summarise, 66% (n=54) of fatally injured cyclists were aged 45 years and over

Figure 1

Victorian Adult On-Road Cyclist Deaths by Age Group (%), 2007-2017



Cause of death information is provided in several ways to allow for detailed recording of the precise circumstances that lead to a person's death. These include the 'underlying cause of death' which is defined as the disease, injury or circumstance which initiated the subsequent events that directly lead to death (ABS, 2008). Multiple cause coding (range: 1-20) allows for the inclusion of additional details such as the intermediate cause, or intervening causes of death as well as any other conditions contributing to the fatality, e.g. nature of injury.

The underlying causes of death are provided in Table 2 below. A large proportion (39%, n=32) of on-road fatalities were due to the cyclist colliding with cars, pick-up trucks or vans, followed by collisions with heavy transport vehicles or buses (22%, n=18). Non-collision transport fatalities accounted for 21% (n=17) of on-road cyclist fatalities and ranged from circumstances such as being thrown, overturning or falling from their bicycles.

Table 2

Underlying Causes of On-Road Adult Cyclist Deaths, 2007-2017

Underlying Causes of Death	N	%
Collided with Car, Pick-Up Truck or Van	32	39.0
Collided with Heavy Transport Vehicle or Bus	18	22.0
Collided with Stationary Object	6	7.3
Non-Collision Transport Event - Fell, Thrown, Overturned	17	20.7
Other Specified & Unspecified Transport Crash	9	11.0
Total	**82**	**100.0**

Multiple causes of death were recorded for all cases, with some recording up to eight associated conditions and/or injuries. A total of 133 conditions were analysed to find that injuries to the head were the leading cause of death (55% of cases, n=45), followed by injuries involving multiple body regions (39% of cases, n=32), injuries to the neck (12%, n=10) and injuries to the thorax/chest (11%, n=9). Overall, injuries represented 72% (n=96) of all associated conditions. Seven (9%) cases had findings of alcohol and/or drug presence or use recorded on their death certificates.

Fatalities were analysed by the day of the week in which they occurred, as depicted in Figure 2. No clear pattern is observed, however, a distinguishable peak occurs on Fridays, representing 18% (n=15) of adult on-road cyclist deaths. Data were also analysed to discern any seasonal effect with regard to cyclist fatalities. Figure 3 below shows a significant peak of on-road adult cyclist fatalities occurring in the summer period (34%, n=28), with slightly lower proportions over autumn and winter (both at 21%, n=17).

Figure 2

Day of the Week of On-Road Adult Cyclist Fatality Occurrence, 2007-2017

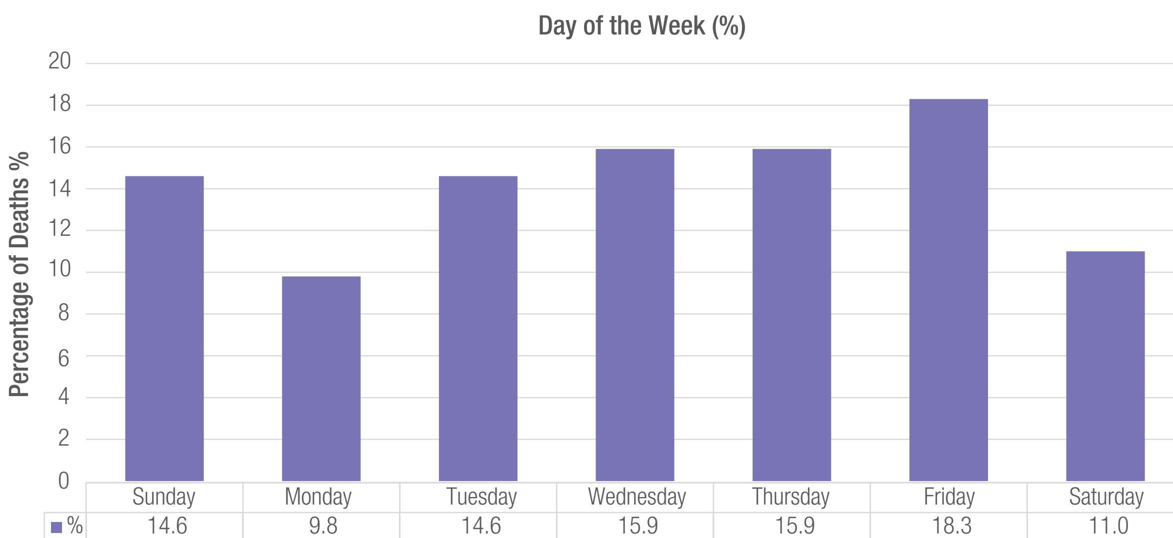
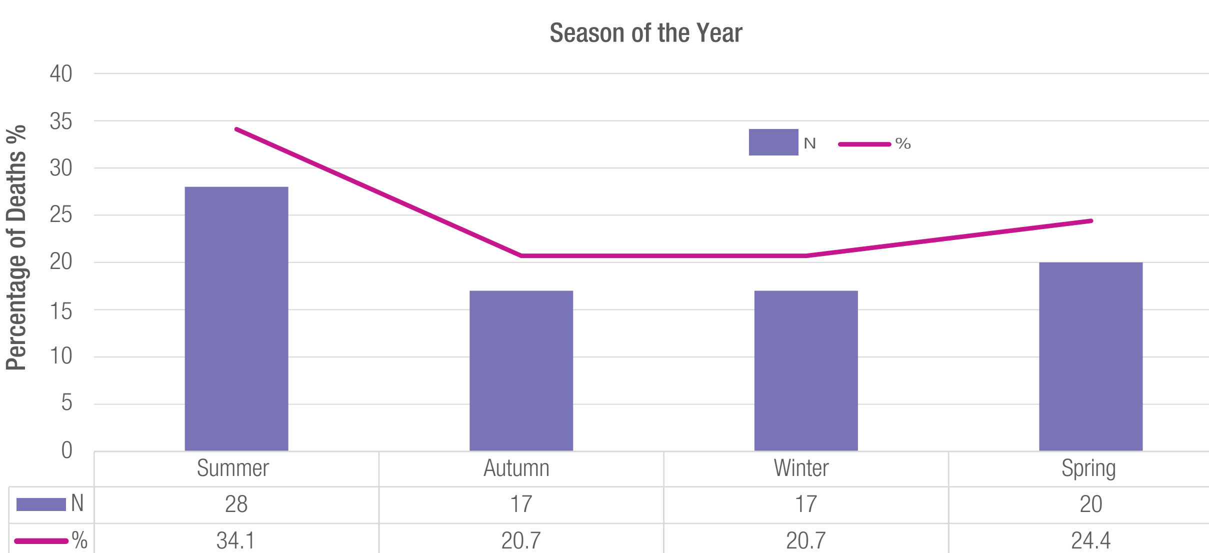


Figure 3

Season of the Year of On-Road Adult Cyclist Fatality Occurrence, 2007-2017



SECTION B:

CYCLIST INJURIES (3 YEARS)

ADULT ON-ROAD CYCLIST INJURY: 2015/16 TO 2017/18, VICTORIA

Ambulance Attendances

There were 4960 ambulance attendances for on-road cyclist related injury among Victorian adults in the three-year period from 2015/16 to 2017/18. Table 3 shows the number of injuries per year and the distribution across age groups and sex. Persons aged 25-34 years made up almost a quarter of all cases; the wider age group 25-44 years accounted 43% of cases. Three-quarters of all cases (74%) were male. Females were relatively overrepresented in the younger age groups: 32% of females were aged 25-34 years; only 20% of males were in this age group. Figure 4 presents an overview of the age of those attended to by an ambulance in relation to on-road cyclist injuries: it shows that persons aged 30-44 years and persons aged 45-64 years each comprise approximately one-third of cases.

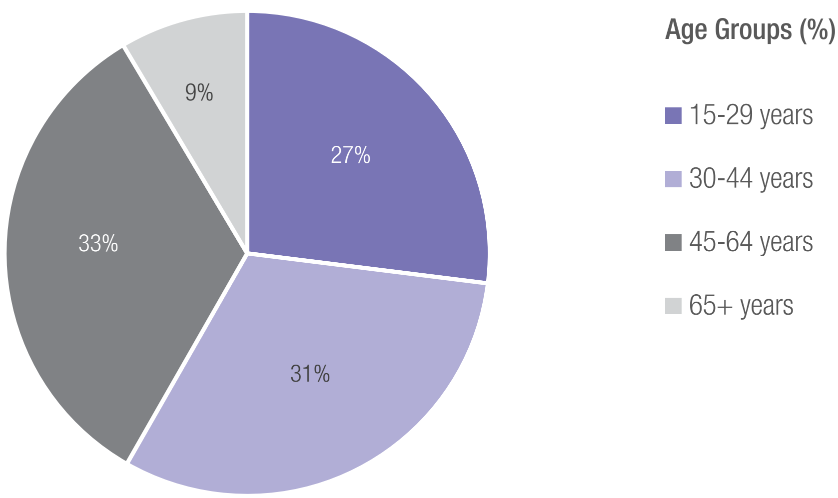
Table 3

On-Road Cyclist Injury-Related Ambulance Attendances, 2015/16 To 2017/18: Attendances by Year, Age Group and Sex

Ambulance Attendances		
	N	%
Year		
2015/16	1802	36.3
2016/17	1520	30.7
2017/18	1638	33.0
Age Group		
15-24 years	740	14.9
25-34 years	1140	23.0
35-44 years	1010	20.4
45-54 years	969	19.5
55-64 years	677	13.7
65-74 years	324	6.5
75 and above	100	2.0
Sex		
Males	3674	74.1
Females	1286	25.9
Total	**4960**	**100.0**

Figure 4

On-Road Cyclist Injury Ambulance Attendances, 2015/16 to 2017/18: Overview of Attendances Per Age Group



In the ambulance attendance data, injury type and bodily region are not recorded in formats similar to those used in the Emergency Department and hospital admissions data. Injury types in the ambulance data are not ICD-10-AM coded due to the lack of diagnostic imaging resources available in the prehospital setting but certain injury types are flagged; however, multiple flags can occur within one case. Establishing mutually exclusive injury type categories would involve adding a hierarchy and therefore introducing potential errors in interpretation. Instead, the number of cases with key injury types are listed as follows:

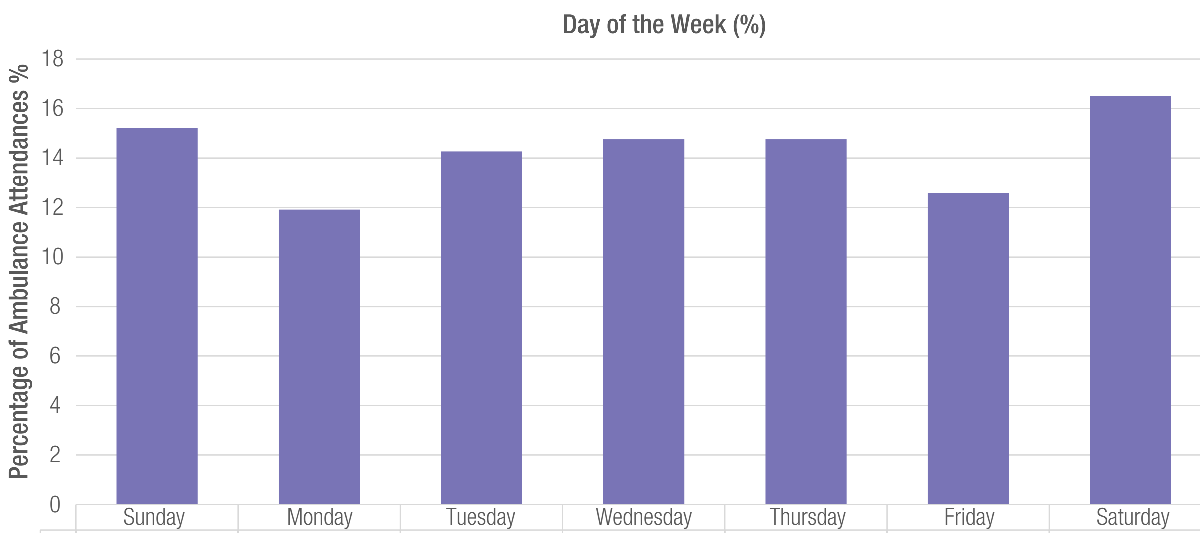
- Suspected spinal cord injury, n=65 (1.3%)
- Blunt abdominal injury, n=55 (1.1%)
- Blunt chest injury, n=204 (4.1%)
- Blunt pelvis injury, n=203 (4.1%)
- Blunt head injury, n=817 (16.5%)
- Bruising/haematoma, n=1071 (21.6%)
- Face injury, n=6 (0.1%)
- Fracture, n=1044 (21.1%)
- Laceration, n=1079 (21.8%)
- Soft tissue injury, n=246 (5.0%)
- Wound puncture, n=87 (1.8%)

Please note that these are *not mutually exclusive* categories and cases could have more than one of the above listed injury types. Only 64% of cases had one of these listed injury types flagged in the ambulance data; 39% had one of these injury types; 17% had two injury types flagged and the remaining 8% had three or more.

The pattern of ambulance attendances for on-road cyclist injury by day of the week is shown in Figure 5. The number of attendances was greatest on Saturdays and Sundays, and the lowest number of attendances were observed on Mondays. This is not necessarily indicative of fluctuations in injury risk to bicycle riders by day of the week, but more likely related to exposure: i.e. fluctuations in bicycle riding and use of certain routes. From these data, it is not possible to distinguish difference in injury risk per day of the week (or commuting vs. recreational cycling), as exposure is not taken into account.

Figure 5

On-Road Cyclist Injury Ambulance Attendances, 2015/16 to 2017/18: Attendances Per Day of the Week



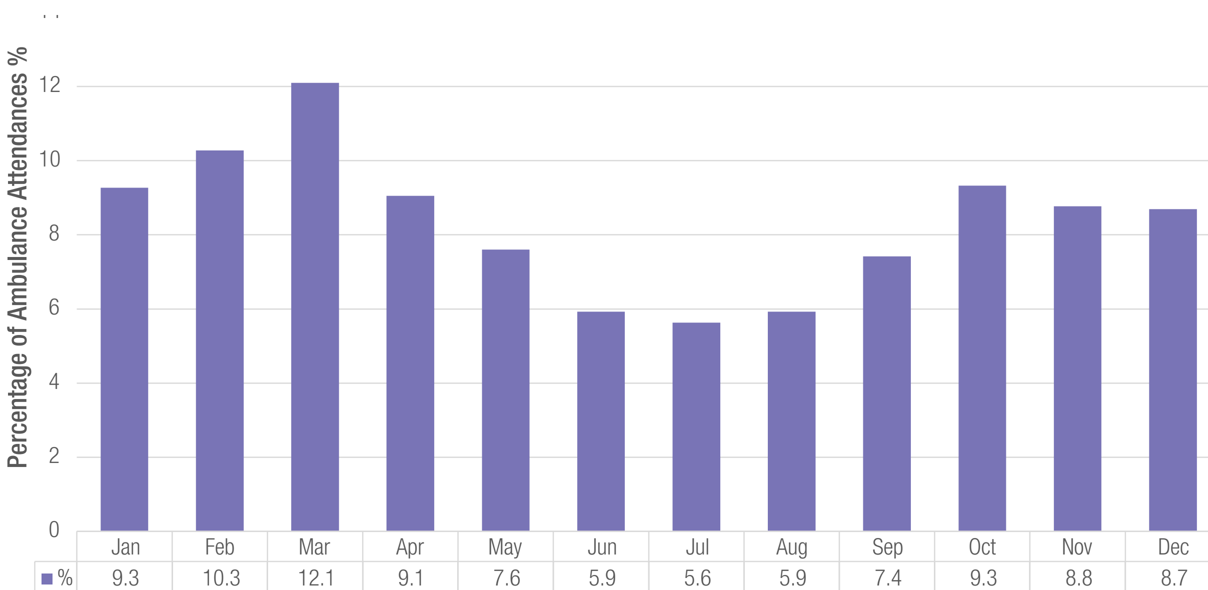
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
%	15.2	11.9	14.3	14.8	14.8	12.6	16.5

THERE ARE MANY POSITIVES TO BE GAINED FROM INCREASED CYCLING PARTICIPATION, HOWEVER, THERE IS A NEED TO ENSURE THAT CYCLING CAN BE UNDERTAKEN SAFELY AND THAT INCREASES IN PARTICIPATION DO NOT RESULT IN A DISPROPORTIONATE INCREASE IN TRAUMA.

Figure 6 shows the monthly variation in ambulance attendances in relation to injured on-road cyclists. Cyclist injuries were most common in March and least common in July: over the three-year period, the number of injuries in March (n=600) was more than double the number of injuries in July (n=279). There was a pronounced seasonal pattern with 28% of ambulance attendances for cyclist injuries occurring in summer, 29% in autumn, 26% in spring and only 17% in winter. This is likely to be related to exposure: i.e., bicycle riding is popular in warmer months; rather than an indication of seasonal variation in injury risk.

Figure 6

On-Road Cyclist Injury Ambulance Attendances, 2015/16 to 2017/18: Attendances per Month of the Year



A large proportion (81.1%) of ambulance attendances resulted in the cyclist being transported to hospital by the attending ambulance. The remaining attendances resulted in the patient being transferred to hospital via other means such as air ambulance or MICA road team (1.7%), being referred to a local GP or other health care provider (2.2%), or instances where the patient refused to be taken to hospital (5.4%). A very small proportion (0.2%) involved patients dying at the scene or on arrival to hospital.

Ambulance Victoria paramedics record detailed narrative descriptions of the injury event. These narratives can be searched for specific terms relating to commonly known injury scenarios. Accurately identifying such injury scenarios depends on the specific search terms and as such injury scenarios may be underestimated. Several variables were created to flag data items such as vehicle type involved for motor vehicle collisions, type of impact involved – (e.g., animals, parked cars), and alcohol/drug use. The search terms used are summarised in Table 4. It should be noted that categories are not mutually exclusive as multiple flags can be derived from each injury event.

A vehicle of some type was noted in 63.8% of adult on-road cyclist injury ambulance attendance records with 37.0% involving a car or equivalent (e.g., utility vehicle, 4WD or SUV, taxi). Roundabouts were recorded for 5.8% of incidents, while the involvement of trams was mentioned in 5.3%, with most of this group involving tram tracks specifically (4.6% of all records).

It should be noted that information regarding alcohol involvement was voluntarily provided by the injured cyclist to the paramedics in attendance. Self-reported alcohol involvement was a factor in 4.5% (n=223) of incidents and most commonly involved males (82%). The most common age group of cyclists attended by ambulance was 35-44 years (28%), followed by 25-34 year olds (25%). Ambulance attendances occurred most often on Saturdays (21%) and Sundays (18%). Summer months represented 37% of attendances. Common injuries included blunt head injuries (34%) and lacerations (33%). A collision with another vehicle was noted in 45% of these records. A small proportion (11%) reported to be travelling a low speed or "walking pace" before their crash. Twenty-five percent had poor or no recollection of the circumstances of their cycling injury event. Helmets were reported to be worn by 35% of cyclists in this subset and not worn by 26%, with the remaining proportion not mentioning the cyclist's helmet status. Several cyclists were reported to have been riding to or from a pub, bottle shop, on a "cycling pub crawl" or on a "wine tasting tour".

Drug use was noted in 0.8% of incidents, with almost half of these reporting marijuana use (0.3% of all records).

Table 4

On-Road Cyclist Injury Ambulance Attendances, 2015/16 to 2017/18: Attendances by Narrative Search Flags of Interest

Narrative Search Term Flag/Group:	Ambulance Attendances*	% of 4960 Attendances
	N	%
Vehicle Type	3165	63.8
Car, Ute, 4WD or SUV, Taxi	*1835*	*37.0*
Truck	*949*	*19.1*
Van	*42*	*0.8*
Hit/Struck Flag	589	11.9
Collision Flag	553	11.1
Roundabout Flag	290	5.8
Parked/Stationary Car Flag	276	5.6
Clipped Flag	275	5.5
Tram Flag	262	5.3
Tram Track Flag	*226*	*4.6*
Alcohol Involvement	223	4.5
Cycling to/from Work Flag	203	4.1
Car Door Flag	158	3.2
Caught in Flag	138	2.8
Group/Bunch Riding Flag	136	2.7
Animal Type Flag	131	2.6
Kangaroo	*26*	*1.4*
Dog	*30*	*0.6*
Pedestrian Involvement	120	2.4
Kerb Involvement Flag	114	2.3
Car or Vehicle Pulled Out Flag	110	2.2
Car or Vehicle Turned in Front of Flag	107	2.2
Bike Lane Flag	105	2.1
Road Race/Cycling Event/Triathlon Flag	94	1.9
Driveway Flag	76	1.5
Pot Hole Flag	65	1.3
Drug Involvement	40	0.8
Marijuana/Cannabis	*17*	*0.3*
Medical Issues Flag	16	0.3

*Please note that these are not mutually exclusive categories and cases could have more than one of the above listed flag types.

Emergency Department Presentations

In the three-year period from 2015/16 to 2017/18, there were 9640 ED presentations for on-road cyclist injury among Victorian adults. The number of injuries per year, distribution across age groups and sex are shown in Table 5. One-quarter of cases were persons aged 25-34 years; the wider age group 25-44 years accounted for close to half of all cases: 45.7%. Three-quarters of all cases were male. Males were slightly older than women, with a median of 38 years vs. 34 years, respectively (p=0.0001). Figure 7 presents an overview of the age of those presenting to the ED for on-road cyclist injuries: it shows that persons aged 15-29 and persons aged 30-44 years each comprise one-third of cases.

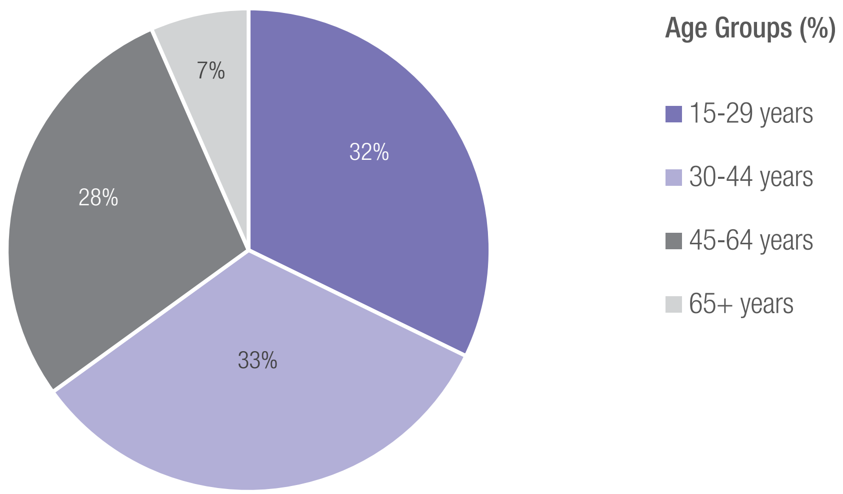
Table 5

On-Road Cyclist Injury ED Presentations, 2015/16 to 2017/18: Presentations by Year, Age Group and Sex

	ED Presentations	
	N	%
Year		
2015/16	3331	34.6
2016/17	3148	32.7
2017/18	3161	32.8
Age group		
15-24 years	1859	19.3
25-34 years	2458	25.5
35-44 years	1951	20.2
45-54 years	1699	17.6
55-64 years	1039	10.8
65-74 years	499	5.2
75 and above	135	1.4
Sex		
Males	7306	75.6
Females	2334	24.2
Total	**9640**	**100.0**

Figure 7

On-Road Cyclist Injury ED Presentations, 2015/16 to 2017/18: Overview of Presentations per Age Group



The most common injury type among persons presenting to the ED in relation to cyclist injury was (bone) fracture, which accounted for one-third of cases (Table 6). Of the fractures (n=3225), fractures of wrist/hand (24%), shoulder/upper arm (23%) and forearm (21%) accounted for over two-thirds of cases (68%). Dislocation, sprain & strain and superficial injuries were also common. In 15% of cases, the injury was 'other' or unspecified. In some cases, the injury type was recorded as intoxication or poisoning (e.g. alcohol); these eight cases are a (vast) underrepresentation of alcohol involvement.

Table 6

On-Road Cyclist Injury ED Presentations, 2015/16 to 2017/18: Overview of Injury Types

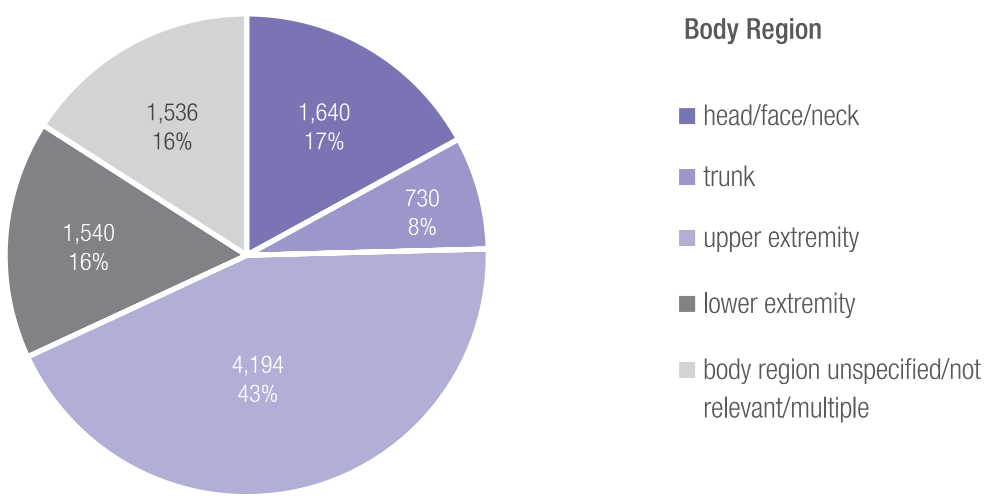
ED Presentations		
Injury Type	N	%
Superficial Injury	1267	13.1
Open Wound	1153	12.0
Fracture	3225	33.5
Dislocation, Sprain & Strain	1650	17.1
Injury to Nerves & Spinal Cord	11	0.1
Injury to Blood Vessels	12	0.1
Injury to Muscle & Tendon	402	4.2
Crushing Injury	76	0.8
Traumatic Amputation	*	*
Other & Unspecified Injury	1470	15.3
Eye Injury - Excl Foreign Body	24	0.3
Intracranial Injury	243	2.5
Injury to Internal Organs	62	0.6
Foreign Body	31	0.3
Burns	*	*
Poisoning Or Toxic Effects†	8	0.1
Total	**9640**	**100**

*Cases have been supressed due to small cell counts; †for example, where fall from bike was associated with alcohol intoxication

The most commonly injured body region was the upper extremity; an overview of body region of the injuries is provided in Figure 8. Among the upper extremity injuries, the most commonly injured region was the shoulder and upper arm (36%), followed by the wrist and hand (35%) and the elbow and forearm (28%). Head injuries and lower extremity injuries were also relatively common (17% and 16%, respectively).

Figure 8

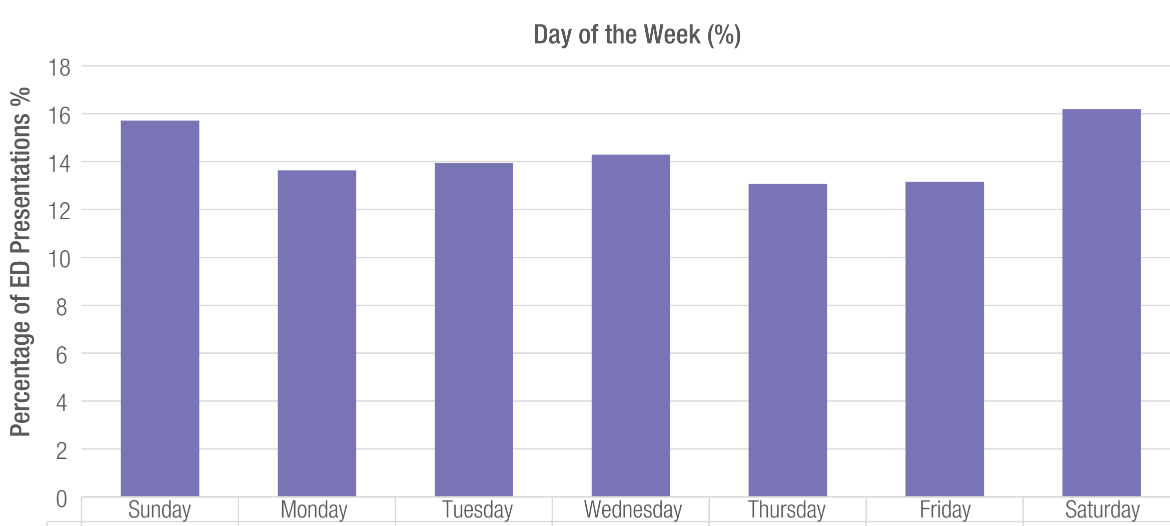
On-Road Cyclist Injury ED Presentations, 2015/16 to 2017/18: Overview of Injured Body Region



The number of cyclist injury presentations to the ED differed per day of the week: the pattern is shown in Figure 9. The number of presentations was highest on Saturdays and Sundays, and lowest on Thursdays and Fridays. This is not necessarily indicative of an increased injury risk to bicycle riders on weekend days, but rather a result of exposure: i.e. bicycle riding is popular on the weekend. From these data, it is not possible to distinguish difference in injury risk per day of the week, as exposure is not taken into account.

Figure 9

On-Road Cyclist Injury ED Presentations, 2015/16 to 2017/18: Presentations per Day of the Week

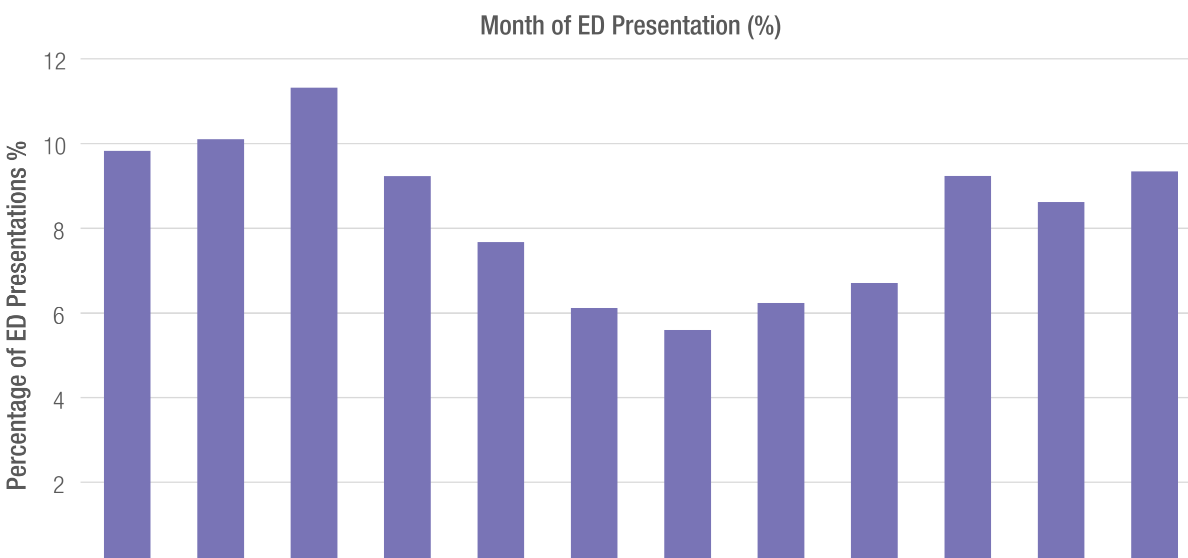


	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
%	15.7	13.6	13.9	14.3	13.1	13.2	16.2

The monthly variation in ED presentations related to cyclist injuries is shown in Figure 10. On-road cyclist injuries were most common in March and least common in July: over the three-year period, the number of injuries in March (n=1091) was more than double the number of injuries in July (n=539). There was a pronounced seasonal pattern with 29% of bicycle injuries presentations occurring in summer, 28% in autumn, 25% in spring and only 18% in winter. This is most likely to be related to exposure: i.e., bicycle riding is popular in warmer months; rather than an indication of seasonal variation in injury risk. The latter cannot be established without seasonal exposure data for bicycle riding in Victoria.

Figure 10

On-Road Cyclist Injury ED Presentations, 2015/16 to 2017/18: Presentations per Month of the Year



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
%	9.8	10.1	11.3	9.2	7.7	6.1	5.6	6.2	6.7	9.2	8.6	9.3

An overview of the departure status of those presenting to the ED in relation to on-road bicycle injuries is shown in Table 7. Those presenting to hospital were most likely discharged to home (66%), with about a third (31%) of ED presentations being admitted to hospital for further treatment. A small proportion were transferred to another hospital, while 75 (1%) cases left before their treatment was completed.

Table 7

On-Road Cyclist Injury ED Presentations, 2015/16 to 2017/18: Overview of Departure Status

ED Presentations		
Departure Status	N	%
Discharge to Home/Returning to Usual Residence	6401	66.4
Admission to Ward - This Campus	3026	31.4
Transfer to Another Hospital Campus	138	1.4
Left Before Treatment Completed	75	0.8
Total	**9640**	**100.0**

Hospital Admissions

From 2015/16 to 2017/18, there were 6301 hospital admissions related to on-road cyclist injury in adults in Victoria. The annual number of injury admissions and the distribution across age groups and sex are shown in Table 8. Cyclist injures were relatively common across the ages of 25 years to 54 years; only a small proportion of injuries occurred among those aged 75 years and above. The 10-year age group with the greatest proportion of cyclist injury admissions was 25-34 years with 22% of adult admissions. Over three-quarters of all cyclist injury admissions were male (77%). Males were marginally older than females, with a median of 42 vs. 41 years (p=0.02). Figure 11 presents an overview of the age of those admitted to hospital for on-road cyclist injury: it shows that persons aged 30 to 64 years make up two-thirds of all adult cases (66%).

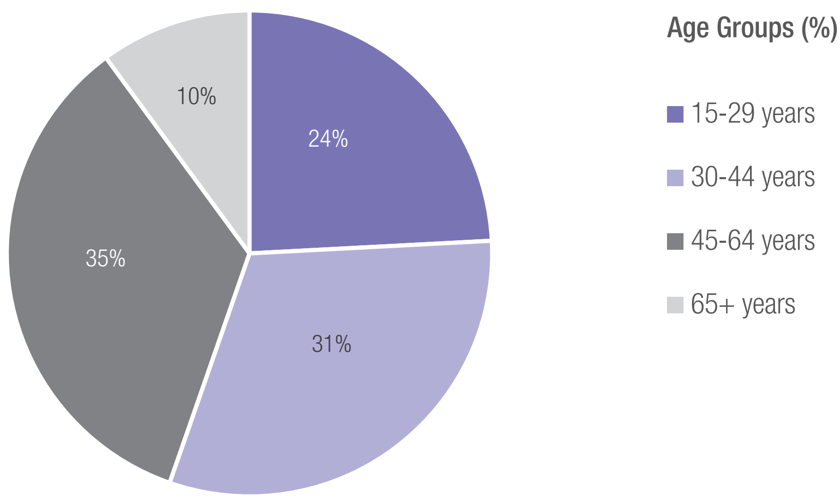
Table 8

On-Road Cyclist Injury Hospital Admissions, 2015/16 to 2017/18: Admissions by Year, Age Group and Sex

Hospital Admissions		
	N	**%**
Year		
2015/16	2037	32.3
2016/17	2042	32.4
2017/18	2222	35.3
Age Group		
15-24 years	864	13.7
25-34 years	1377	21.9
35-44 years	1246	19.8
45-54 years	1214	19.3
55-64 years	965	15.3
65-74 years	486	7.7
75 and above	149	2.4
Sex		
Males	4853	77.0
Females	1448	23.0
Total	**6301**	**100.0**

Figure 11

On-Road Cyclist Injury Hospital Admissions, 2015/16 to 2017/18: Overview of Admissions per Age Group



IN ORDER TO FACILITATE GROWTH IN [CYCLING] PARTICIPATION THERE IS A NEED TO ADDRESS SAFETY ISSUES, ESPECIALLY FOR ON-ROAD CYCLING AND ROADS WITH HIGHER TRAFFIC VOLUMES AND VEHICULAR SPEEDS.

Of the 6301 injury admissions, 4585 (72.8%) were classified as caused in traffic, 610 (9.7%) as caused in non-traffic, and the remaining 1106 (17.6%) as other and unspecified (n=1100) or occurring while boarding or alighting (n=6).

An overview of the injury cause is provided in Table 9. Non-collision transport accident was the commonly recorded cause of cyclist injury admissions. Among recorded collisions, collision with a car, pick-up or van was the most common cause (24% of all admissions), followed by collision with another pedal cycle (6%) and collision with a fixed/stationary object (6%). Collision with pedestrian (or animal) was relatively rarely reported (1.5%). In 18% of cases, the specific cause of the on-road bicycle injury was other or unspecified.

Table 9

On-Road Cyclist Injury Hospital Admissions, 2015/16 to 2017/18: Number of Admissions per Cause Group

Hospital Admissions		
Pedal Cycle Injury Cause	N	%
Collision with Pedestrian or Animal	93	1.5
Collision with Other Pedal Cycle	368	5.8
Collision with Two- or Three-Wheeled Motor Vehicle	*	*
Collision with Car, Pick-Up Truck or Van	1536	24.4
Collision with Heavy Transport Vehicle or Bus	55	0.9
Collision with Railway Train or Railway Vehicle	*	*
Collision with Other Non-Motor Vehicle	16	0.3
Collision with Fixed or Stationary Object	347	5.5
Non-Collision Transport Accident	2774	44.0
Other and Unspecified Transport Accidents	1100	17.5
Total	**6301**	**100**

*Cases have been supressed due to small cell counts

The most common type of injury among persons admitted to hospital in relation to a bicycle injury was (bone) fracture, which accounted for 57% of cases. Of these fractures (n=3571), fracture of shoulder and upper arm (26%), fracture of forearm (21%), fracture at wrist and hand level (11%), and fracture of skull and facial bones (10%) accounted for over two-thirds of cases (68%). Open wounds were also relatively common; of the 631 cases, almost half (48%) were *open wound of the head.*

Table 10

On-Road Cyclist Injury Hospital Admissions, 2015/16 to 2017/18: Overview of Injury Types

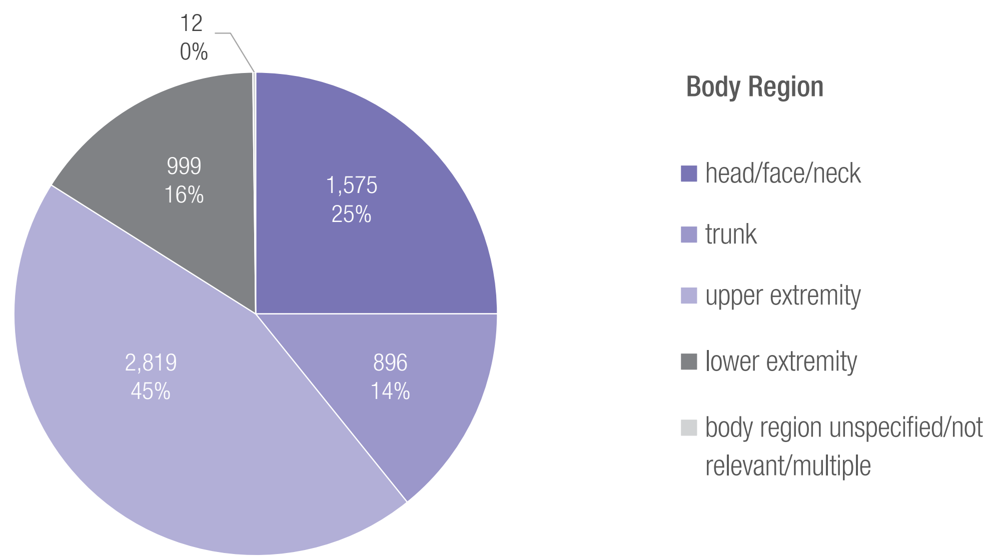
Hospital Admissions		
Injury Type	N	%
Superficial Injury	512	8.1
Open Wound	631	10.0
Fracture	3571	56.7
Dislocation, Sprain & Strain	365	5.8
Injury to Nerves & Spinal Cord	37	0.6
Injury to Blood Vessels	11	0.2
Injury to Muscle & Tendon	107	1.7
Crushing Injury	*	*
Traumatic Amputation	*	*
Eye Injury- Excl Foreign Body	6	0.1
Intracranial Injury	387	6.1
Injury to Internal Organs	143	2.3
Foreign Body	*	*
Burns	*	*
Other & Unspecified Injury	521	8.3
Other Effects of External Causes/Complications/Late Effects	*	*
Total	**6301**	**100**

*Cases have been supressed due to small cell counts

The most commonly injured body region was the upper extremity; Figure 12 provides an overview of body region injured. Of the upper extremity injuries (n=2819), the most common were shoulder and upper arm injuries (46%), followed by elbow and forearm injuries (33%) and wrist and hand injuries (21%). Head/face/neck injuries were also common (n=1575); these were mainly head injuries (84%) and less commonly, neck injuries (16%).

Figure 12

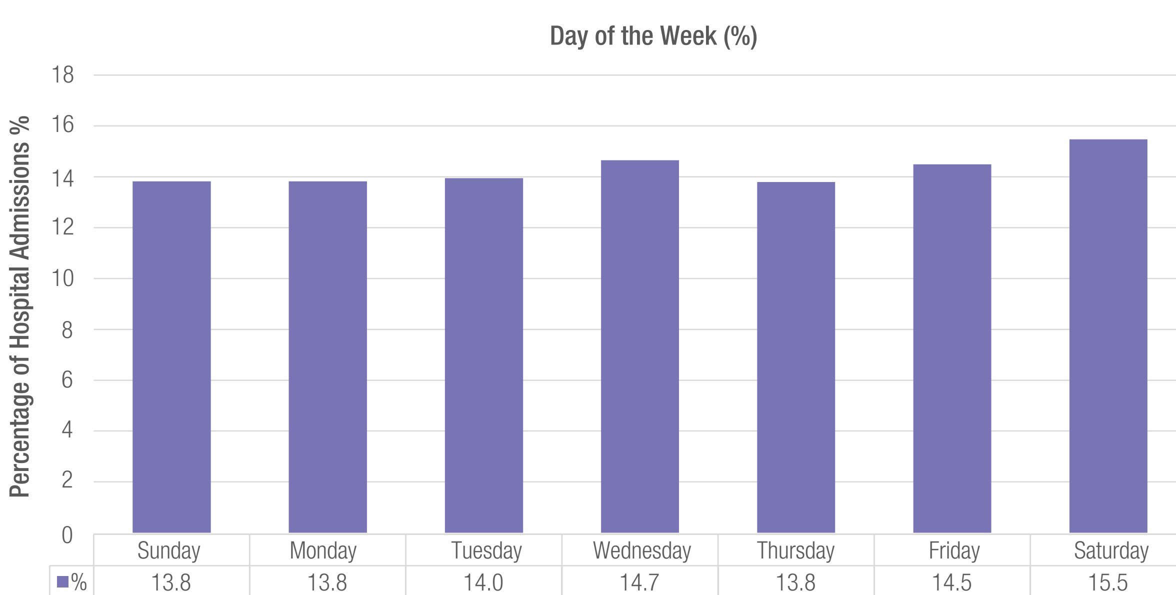
On-Road Cyclist Injury Hospital Admissions, 2015/16 to 2017/18: Overview of Injured Body Region



The number of cyclist injury admissions differed per day of the week; Figure 13 shows the pattern per weekday. The number of presentations was highest on Saturdays, followed by Wednesdays and Fridays. Overall, however, the variation by day of the week was not pronounced, and there was no marked weekend day vs. weekday difference distinguishable in the admissions, although this was observed in the ED presentations (Figure 9).

Figure 13

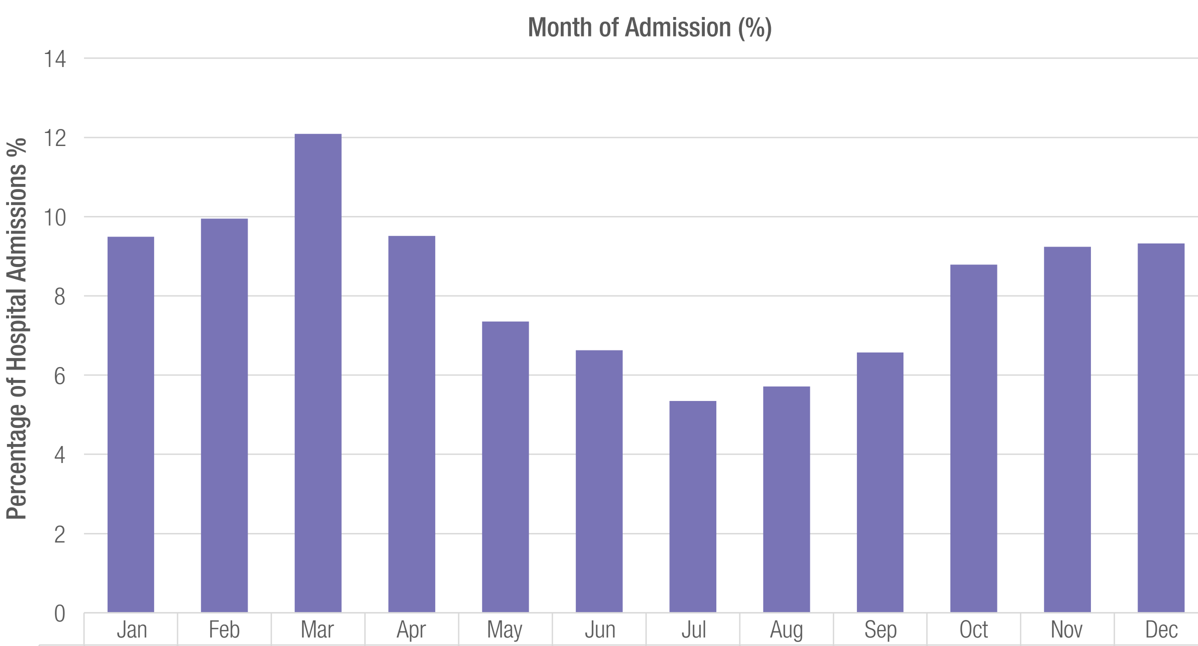
On-Road Cyclist Injury Hospital Admissions, 2015/16 to 2017/18: Admissions per Day of the Week



The monthly variation in cyclist injury admissions is shown in Figure 14. On-road cyclist injuries were most common in March and least common in July; a similar pattern was observed in ED presentations by month of the year. The number of hospital admissions in March (n=762) was more than double the number of admissions in July (n=337). There was a pronounced seasonal pattern, with cyclist injury admissions occurring most commonly in summer (29%) and autumn (29%) and least commonly in winter (18%), the remaining 25% of injury admissions occurred in spring. This is most likely a reflection of the popularity of bike riding in fine weather, i.e. variation in exposure, rather than a seasonal variation in injury risk. The latter cannot be measured without (seasonal) bicycle riding exposure data.

Figure 14

On-Road Cyclist Injury Hospital Admissions, 2015/16 to 2017/18: Admissions per Month of the Year



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
%	9.5	10.0	12.1	9.5	7.4	6.6	5.4	5.7	6.6	8.8	9.2	9.3

BURDEN OF ON-ROAD CYCLIST INJURY: 2015/16 – 2017/18 (THREE YEARS)

In the period 2015/16 to 2017/18, there were five in-hospital deaths among cycling-related injury admissions. Among the 6301 admissions, serious injury, indicated by ICISS score of less than 0.941 (Stephenson et al., 2003), was relatively common: 780 (12.4%) cases sustained severe injuries. Severe injuries were more common with increasing age: 5.9% of cases in the age group 15-29 years, 7.7% in the age group 30-44 years, 10.0% in the age group 45-64 years and 40.3% in those aged 65 years and above.

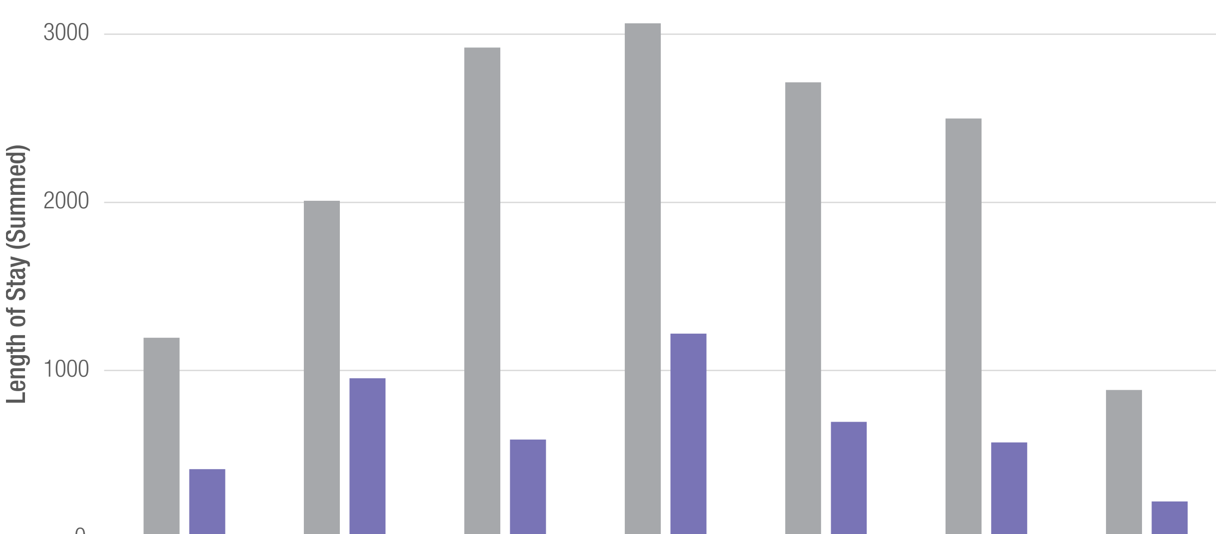
Length of Stay

Hospital beds were occupied for 19,953 days as a result of cyclist injury. More than three-quarters (76.6%, n=15,288) of total bed days were accounted for by males and compared to females, males accounted for more bed days in all age groups (Figure 15).

Broken down by age group, the greatest disparity between males and females was observed among the 35-44 year bracket where hospital beds were occupied by males for 2921 days compared to 590 days for females (ratio 5:1).

Figure 15

Summed Length of On-Road Cyclist Injury Hospital Admission Stay (Days) by Age Group and Sex, Victoria, 2015/16-2017/18



	15-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75 years and older
Male	1195	2010	2921	3065	2714	2499	884
Female	414	954	590	1219	695	572	221

An overview of hospital admission bed days by cyclist injury cause and patient demographics is provided in Table 11. Overall, 46% of bed days were attributed to *collision* bicycle crashes, 38% to *non-collision* bicycle crashes and 15% to *other and unspecified* bicycle crashes. There were no marked differences in bed days per cause by age and sex, with exception of an overrepresentation bed days among males aged 35-44 years in *collision* crashes and overrepresentation of bed days among males age 45-54 years in *other and unspecified* crashes.

Table 11

Summed Length of Hospital Admission Stay (Days) per Cyclist Injury Cause, by Age Group and Sex, Victoria, 2015/16-2017/18

	Hospital Admissions			
	Collision	Non-Collision	Other & Unspecified	Overall†
Males				
15-24 years	459 (5.0%)	497 (6.5%)	239 (7.8%)	1195 (6.0%)
25-34 years	1017 (11.0%)	708 (9.3%)	285 (9.3%)	2010 (10.1%)
35-44 years	1667 (18.0%)	940 (12.3%)	314 (10.2%)	2921 (14.6%)
45-54 years	1337 (14.4%)	1092 (14.3%)	636 (20.7%)	3065 (15.4%)
55-64 years	1260 (13.6%)	1109 (14.6%)	345 (11.2%)	2714 (13.6%)
65-74 years	1159 (12.5%)	934 (12.3%)	406 (13.2%)	2499 (12.5%)
75+ years	183 (2.0%)	542 (7.1%)	159 (5.2%)	884 (4.4%)
Male Total	7082 (76.5%)	5822 (76.4%)	2384 (77.5%)	15288 (76.6%)
Females				
15-24 years	239 (2.6%)	134 (1.8%)	41 (1.3%)	414 (2.1%)
25-34 years	496 (5.4%)	337 (4.4%)	121 (3.9%)	954 (4.8%)
35-44 years	186 (2.0%)	355 (4.7%)	49 (1.6%)	590 (3.0%)
45-54 years	643 (6.9%)	404 (5.3%)	172 (5.6%)	1219 (6.1%)
55-64 years	270 (2.9%)	298 (3.9%)	127 (4.1%)	695 (3.5%)
65-74 years	225 (2.4%)	176 (2.3%)	171 (5.6%)	572 (2.9%)
75+ years	118 (1.3%)	90 (1.2%)	13 (0.4%)	221 (1.1%)
Female Total	2177 (23.5%)	1794 (23.6%)	694 (22.5%)	4665 (23.4%)
Grand Total	**9259 (100%)**	**7616 (100%)**	**3078 (100%)**	**19953 (100%)**

†As some cases involved multiple codes, this column should be considered separately. It will often be smaller than the sum of each 'code' column as the code columns are not independent, whilst the 'overall' bed days were calculated with overlapping codes taken into account. Calculations for length of hospital stay included transfers within and between hospitals to more accurately estimate burden of injury.

An analysis of the length of stay showed that 65.3% (n=4486) of admissions resulted in the utilisation of fewer than two bed days. Similarly, the breakdown by sex showed that males and females experienced a similar proportion of stays fewer than two days (64.9%, n=3439 vs. 66.7%, n=1047 respectively). This result is also reproduced among longer stays; males and females were equally likely to experience stays of 2-7 days (28.0% vs. 26.0% respectively) with similar patterns repeated for stays of 8-30 days and 31+ days.

The breakdown by age showed that as age increased, stays of two days or longer become more common. For example, among the youngest cyclists, 22.4% of stays were for two or more days (n=203 of 906) whereas among those aged 75 years and older, 64.4% of stays were for two or more days (n=125 of 194).

Table 12

Length of Stay (Categories) of Cyclist Injury Hospital Admissions by Age Group and Sex, Victoria, 2015/16-2017/18

	Hospital Admissions*				
	<2 days (row %)	2-7 days (row %)	8-30 days (row %)	31+ days (row %)	Total
Males					
15-24 years	554 (78.1%)	140 (19.7%)	14 (2.0%)	1 (0.1%)	709
25-34 years	785 (77.2%)	200 (19.7%)	27 (2.7%)	5 (0.5%)	1017
35-44 years	734 (67.6%)	295 (27.2%)	47 (4.3%)	10 (0.9%)	1086
45-54 years	634 (62.7%)	305 (30.2%)	62 (6.1%)	10 (1.0%)	1011
55-64 years	457 (54.5%)	303 (36.2%)	73 (8.7%)	5 (0.6%)	838
65-74 years	214 (45.2%)	175 (37.0%)	76 (16.1%)	8 (1.7%)	473
75+ years	61 (36.7%)	67 (40.4%)	34 (20.5%)	4 (2.4%)	166
Male Total	3439 (64.9%)	1485 (28.0%)	333 (6.3%)	43 (0.8%)	5300
Females					
15-24 years	149 (75.6%)	40 (20.3%)	7 (3.6%)	1 (0.5%)	197
25-34 years	305 (74.0%)	86 (20.9%)	18 (4.4%)	3 (0.7%)	412
35-44 years	176 (72.1%)	60 (24.6%)	6 (2.5%)	2 (0.8%)	244
45-54 years	208 (65.4%)	79 (24.8%)	25 (7.9%)	6 (1.9%)	318
55-64 years	136 (57.1%)	81 (34.0%)	21 (8.8%)	0 (0.0%)	238
65-74 years	65 (49.2%)	50 (37.9%)	14 (10.6%)	3 (2.3%)	132
75+ years	8 (28.6%)	12 (42.9%)	7 (25.0%)	1 (3.6%)	28
Female Total	1047 (66.7%)	408 (26.0%)	98 (6.2%)	16 (1.0%)	1569
Persons					
15-24 years	703 (77.6%)	180 (19.9%)	21 (2.3%)	2 (0.2%)	906
25-34 years	1090 (76.3%)	286 (20.0%)	45 (3.1%)	8 (0.6%)	1429
35-44 years	910 (68.4%)	355 (26.7%)	53 (4.0%)	12 (0.9%)	1330
45-54 years	842 (63.4%)	384 (28.9%)	87 (6.5%)	16 (1.2%)	1329
55-64 years	593 (55.1%)	384 (35.7%)	94 (8.7%)	5 (0.5%)	1076
65-74 years	279 (46.1%)	225 (37.2%)	90 (14.9%)	11 (1.8%)	605
75+ years	69 (35.6%)	79 (40.7%)	41 (21.1%)	5 (2.6%)	194
Grand Total	**4486 (65.3%)**	**1893 (27.6%)**	**431 (6.3%)**	**59 (0.9%)**	**6869**

*Total N=6,869 includes transfers within and between hospitals to more accurately estimate burden of injury.

Hospital Costs

An overview of cyclist injury hospital admission costs for the three-year period 2015/16 to 2017/18 is given in Table 13. Overall, there was an estimated total of $41.3m AUD in hospital costs for this time period. Of this total, 78.7% ($32.4 AUD) was accounted for by males. Approximately three-quarters of the total costs were accounted for by persons aged 25-64 years (73.4%). A breakdown by sex revealed several differences in cost distribution per age group, between males and females. Among females, 22.6% ($2.0m AUD) of costs were attributed to the 25-34 year age group, whilst for males 14.9% ($4.8m AUD) was attributed to the same age group. Conversely, among males, 19.1% ($6.2m AUD) of costs were attributed to the 35-44 year age group, whilst for females 15.6% ($1.4m AUD) was attributed to the same age group.

Table 13

Cost of On-Road Cyclist Injury Hospital Admissions by Age Group and Sex, Victoria, 2015/16-2017/18

	Males		Females		Persons	
	AU$	%	AU$	%	AU$	%
Age Groups						
15-24 years	$3,284,592	10.1	$748,873	8.5	$4,033,465	9.8
25-34 years	$4,825,467	14.9	$1,987,418	22.6	$6,812,885	16.5
35-44 years	$6,205,514	19.1	$1,372,033	15.6	$7,577,547	18.4
45-54 years	$6,625,544	20.4	$1,975,861	22.4	$8,601,405	20.8
55-64 years	$5,739,026	17.7	$1,564,104	17.8	$7,303,130	17.7
65-74 years	$4,298,188	13.2	$949,238	10.8	$5,247,426	12.7
75+ years	$1,507,947	4.6	$206,129	2.3	$1,714,076	4.2
Total	**$32,486,278**	**100.0**	**$8,803,656**	**100.0**	**$41,289,934**	**100.0**

NB. Calculations for costs of hospital admissions included transfers within and between hospitals to more accurately estimate burden of injury.

PLACE OF OCCURRENCE

An overview of the total ambulance attendances for each LGA by the call-out location and rate per 100,000 population for adult on-road cyclist injuries between 2015/16 to 2017/18 are summarised in Figure 16, Figure 17 and Table 14. The findings illustrate the highest number of on-road cyclists injuries occurred in the City of Melbourne (n = 1,014), Bayside City Council (n = 263), Darebin City Council (n = 252) and the City of Greater Geelong (n = 178).

Ambulance attendance rates based on LGA of attendance per 100,000 population were highest for the City of Melbourne (236 per 100,000) and Alpine Shire Council (244 per 100,000). However, it should be noted that not all injuries involve residents of the LGA and injuries may be sustained by cyclists visiting the area. When considering bicycle injuries by place of occurrence, bicycle injury frequencies (Figure 16) are more informative than the population-based rates (Figure 17), which account for the residential population, not for the number of cyclists in the area.

Figure 16

Number of Ambulance Attendances in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Ambulance Call-Out Location.

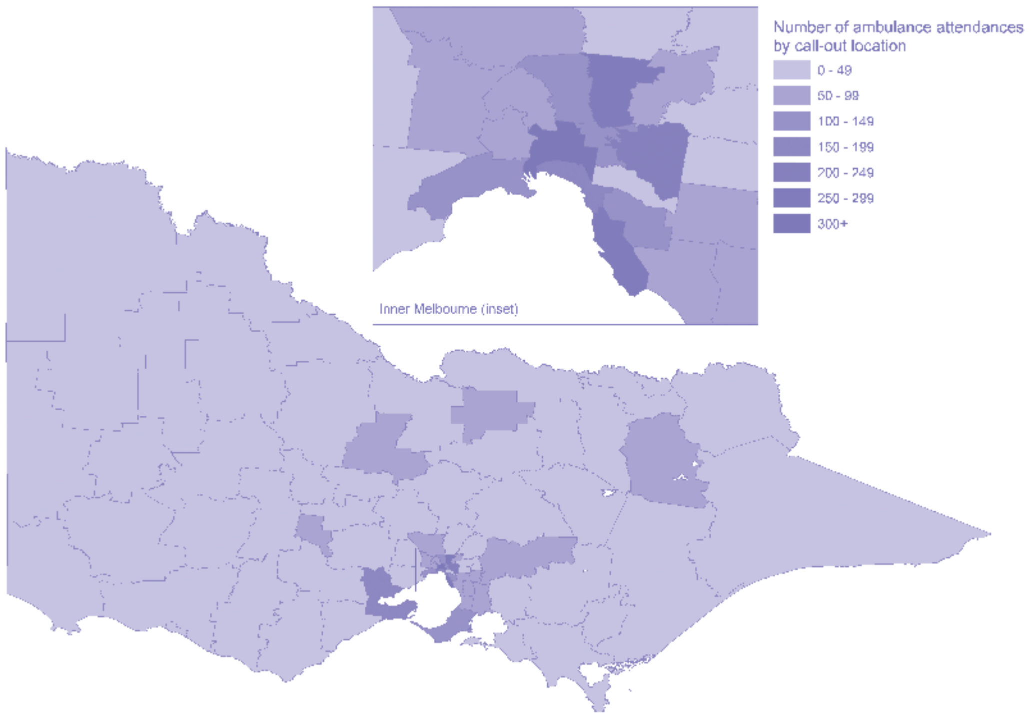


Figure 17

Rate (Per 100,000 Population) of Ambulance Attendances in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Ambulance Call-Out Location

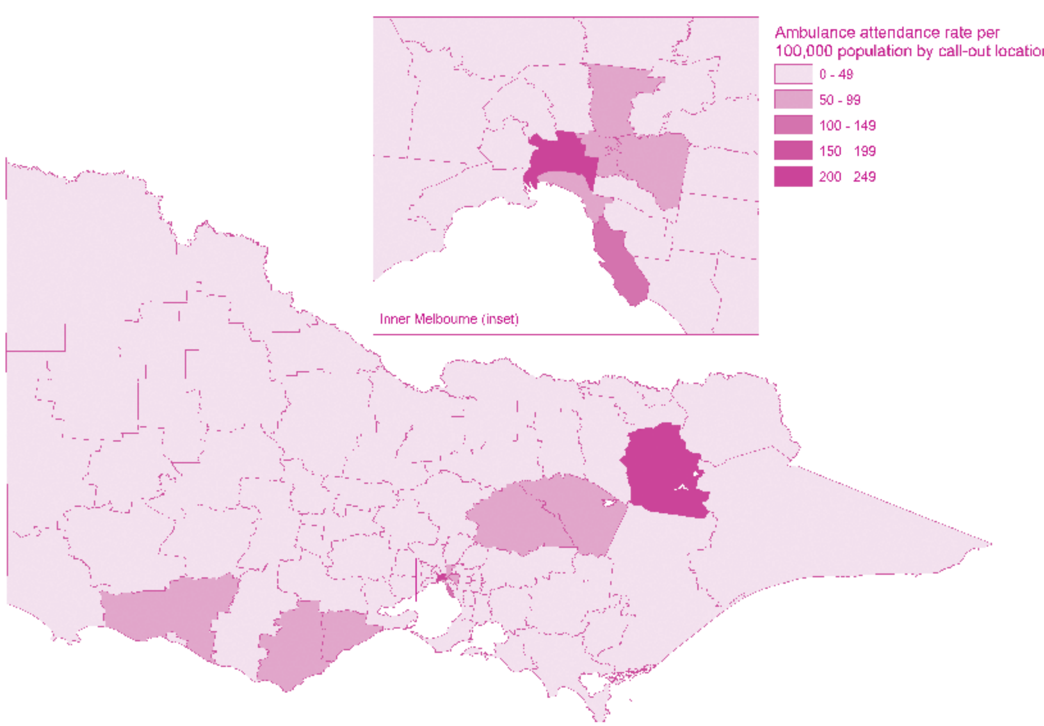


Table 14

Table Overview of Ambulance Attendances in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Ambulance Call-Out Location

Local Government Area	Summed Attendances*	Attendances per 100,000 Population†	Local Government Area	Summed Attendances*	Attendances per 100,000 Population†
Alpine (S)	77	244	Macedon Ranges (S)	36	32
Ararat (RC)	5	†	Manningham (C)	47	15
Ballarat (C)	60	24	Mansfield (S)	20	93
Banyule (C)	90	29	Maribyrnong (C)	99	45
Bass Coast (S)	25	30	Maroondah (C)	28	10
Baw Baw (S)	36	30	Melbourne (C)	1014	236
Bayside (C)	263	105	Melton (C)	32	10
Benalla (RC)	15	43	Mildura (RC)	27	20
Boroondara (C)	226	51	Mitchell (S)	9	†
Brimbank (C)	87	17	Moira (S)	11	15
Buloke (S)	0	0	Monash (C)	83	17
Campaspe (S)	12	13	Moonee Valley (C)	92	30
Cardinia (S)	31	13	Moorabool (S)	7	†
Casey (C)	92	12	Moreland (C)	123	28
Central Goldfields (S)	12	36	Mornington Peninsula (S)	132	33
Colac-Otway (S)	27	51	Mount Alexander (S)	20	41
Corangamite (S)	*	†	Moyne (S)	37	93
Darebin (C)	252	64	Murrindindi (S)	26	73
East Gippsland (S)	35	30	Nillumbik (S)	39	25
Frankston (C)	84	25	Northern Grampians (S)	5	†
Gannawarra (S)	*	†	Port Phillip (C)	163	56
Glen Eira (C)	122	33	Pyrenees (S)	0	0
Glenelg (S)	15	30	Queenscliff (B)	0	0
Golden Plains (S)	5	†	South Gippsland (S)	14	20
Greater Bendigo (C)	86	32	Southern Grampians (S)	13	33
Greater Dandenong (C)	81	20	Stonnington (C)	49	17
Greater Geelong (C)	178	30	Strathbogie (S)	*	†
Greater Shepparton (C)	52	33	Surf Coast (S)	37	50
Hepburn (S)	13	33	Swan Hill (RC)	*	†
Hindmarsh (S)	*	†	Towong (S)	*	†
Hobsons Bay (C)	106	46	Wangaratta (RC)	19	27
Horsham (RC)	8	†	Warrnambool (C)	0	0
Hume (C)	72	15	Wellington (S)	22	21
Indigo (S)	12	30	West Wimmera (S)	0	0
Kingston (C)	88	22	Whitehorse (C)	24	6
Knox (C)	72	18	Whittlesea (C)	38	8
Latrobe (C)	16	9	Wodonga (C)	20	21
Loddon (S)	6	†	Wyndham (C)	41	8

*Cases less than five are suppressed; †rates for cases less than ten are suppressed.

Total ambulance attendances for each LGA by place of residence and rate per 100,000 population for adult on-road cyclists injured between 2015/16 and 2017/18 are summarised in Figure 18, Figure 19 and Table 15. The findings illustrate the greatest number of injured on-road cyclists resided in the City of Melbourne (n = 570), the City of Boroondara (n = 464) and Frankston City Council (n = 430). Ambulance attendance rates based on the LGA of residence per 100,000 population were highest for the City of Melbourne (133 per 100,000), Bayside City Council (133 per 100,000) and Frankston City Council (126 per 100,000). Interestingly, there were differences between the place of residence and location of ambulance attendance, signifying that many adult on-road cyclists were injured outside their LGA of residence.

Figure 18

Number of Ambulance Attendances in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence

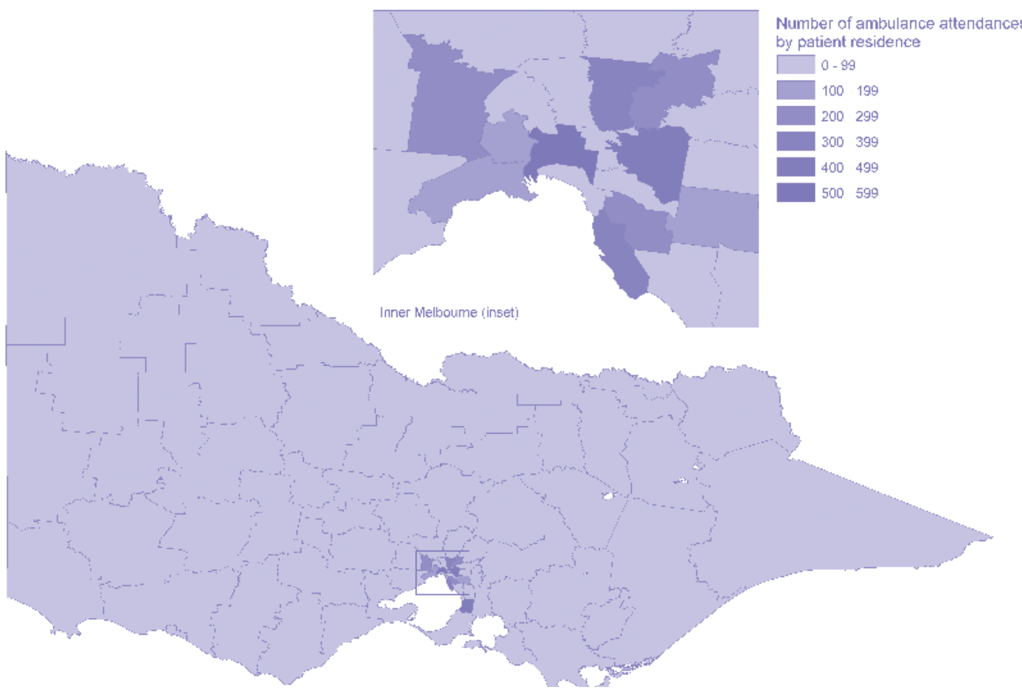


Figure 19

Rate (Per 100,000 Population) of Ambulance Attendances in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence

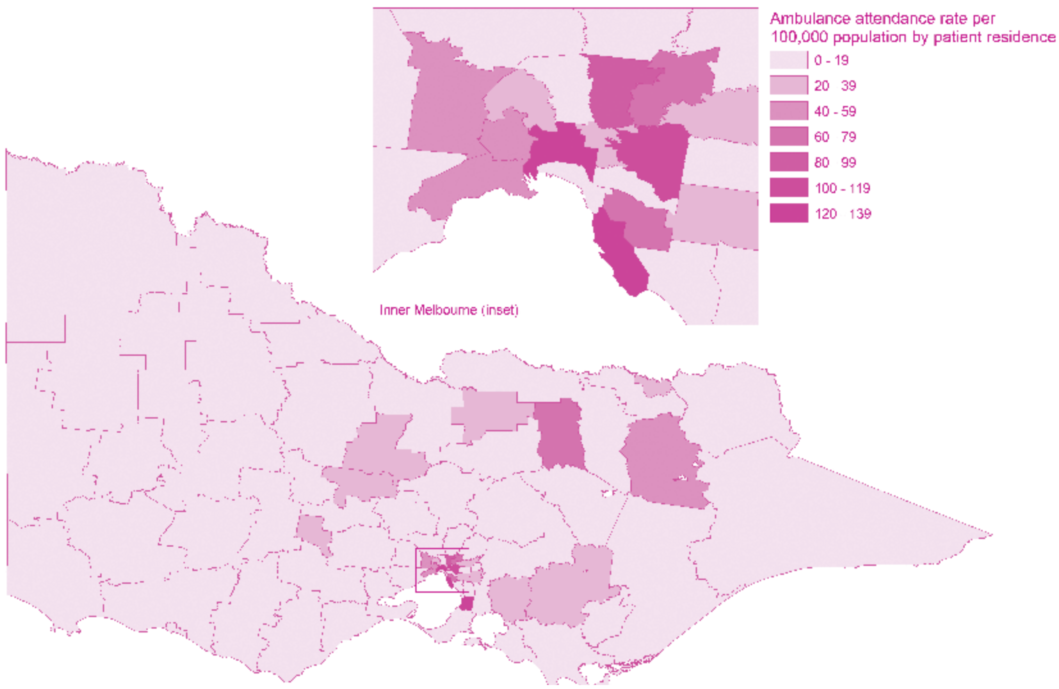


Table 15

Table Overview of Ambulance Attendances in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence

Local Government Area	Summed Attendances*	Attendances per 100,000 Population†	Local Government Area	Summed Attendances*	Attendances per 100,000 Population†
Alpine (S)	17	54	Macedon Ranges (S)	15	13
Ararat (RC)	*	†	Manningham (C)	85	27
Ballarat (C)	73	29	Mansfield (S)	5	†
Banyule (C)	204	65	Maribyrnong (C)	109	49
Bass Coast (S)	16	19	Maroondah (C)	53	19
Baw Baw (S)	37	31	Melbourne (C)	570	133
Bayside (C)	335	133	Melton (C)	27	8
Benalla (RC)	22	63	Mildura (RC)	5	†
Boroondara (C)	464	105	Mitchell (S)	9	†
Brimbank (C)	231	46	Moira (S)	10	14
Buloke (S)	0	0	Monash (C)	101	21
Campaspe (S)	6	†	Moonee Valley (C)	84	27
Cardinia (S)	63	27	Moorabool (S)	*	†
Casey (C)	99	13	Moreland (C)	83	19
Central Goldfields (S)	0	0	Mornington Peninsula (S)	63	16
Colac-Otway (S)	6	†	Mount Alexander (S)	10	21
Corangamite (S)	*	†	Moyne (S)	5	†
Darebin (C)	350	88	Murrindindi (S)	*	†
East Gippsland (S)	13	11	Nillumbik (S)	11	7
Frankston (C)	430	126	Northern Grampians (S)	*	†
Gannawarra (S)	*	†	Port Phillip (C)	52	18
Glen Eira (C)	258	70	Pyrenees (S)	*	†
Glenelg (S)	0	0	Queenscliff (B)	0	0
Golden Plains (S)	*	†	South Gippsland (S)	*	†
Greater Bendigo (C)	59	22	Southern Grampians (S)	*	†
Greater Dandenong (C)	73	18	Stonnington (C)	*	†
Greater Geelong (C)	*	†	Strathbogie (S)	*	†
Greater Shepparton (C)	49	31	Surf Coast (S)	5	†
Hepburn (S)	5	†	Swan Hill (RC)	*	†
Hindmarsh (S)	5	†	Towong (S)	0	0
Hobsons Bay (C)	118	51	Wangaratta (RC)	0	0
Horsham (RC)	*	†	Warrnambool (C)	0	0
Hume (C)	52	11	Wellington (S)	5	†
Indigo (S)	9	†	West Wimmera (S)	0	0
Kingston (C)	60	15	Whitehorse (C)	20	5
Knox (C)	84	21	Whittlesea (C)	48	10
Latrobe (C)	*	†	Wodonga (C)	24	25
Loddon (S)	*	†	Wyndham (C)	19	4

*Cases less than five are suppressed; †rates for cases less than ten are suppressed.

Emergency Department presentations for each LGA by place of residence and rate per 100,000 population for adult on-road cyclists injured between 2015/16 to 2017/18 are summarised in Figure 20, Figure 21 and Table 16. The findings illustrate the greatest number of ED presentations resided in the City of Melbourne (n = 483), Moreland City Council (n = 745) and the City of Darebin (n = 561). ED presentation rates by LGA of residence per 100,000 population were highest for Moreland City Council (169 per 100,000), the City of Darebin (142 per 100,000) and the City of Maribyrnong (139 per 100,000).

Figure 20

Number of Emergency Department Presentations in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence

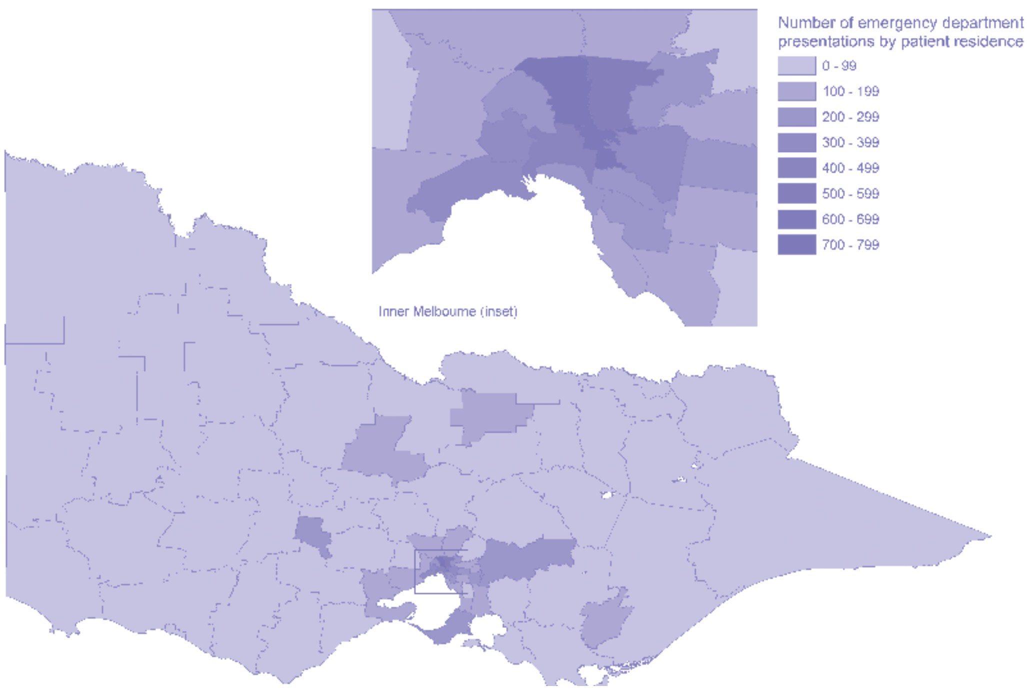
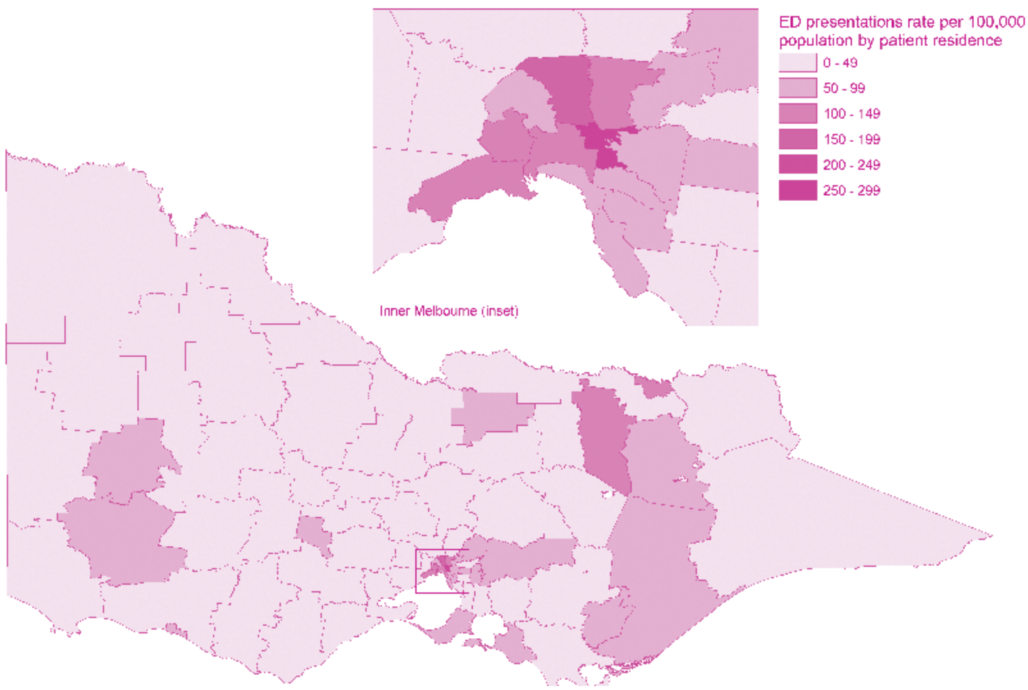


Figure 21

Rate (Per 100,000 Population) of Emergency Department Presentations in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence



BY DEVELOPING A HOLISTIC UNDERSTANDING OF THE CURRENT LEVELS OF TRAUMA EXPERIENCED BY PEOPLE RIDING BICYCLES, KEY ROAD SAFETY ISSUES CAN BE IDENTIFIED FOR BICYCLE RIDERS AND THE FINDINGS CAN INFORM POLICY, LEGISLATION AND THE DEVELOPMENT OF INFRASTRUCTURE NEEDED TO GROW PARTICIPATION WHILE REDUCING THE BURDEN OF INJURY.

Table 16

Table Overview of Emergency Department Presentations in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence

Local Government Area	Summed Attendances*	Attendances per 100,000 Population†	Local Government Area	Summed Attendances*	Attendances per 100,000 Population†
Alpine (S)	17	54	Macedon Ranges (S)	47	41
Ararat (RC)	0	0	Manningham (C)	119	38
Ballarat (C)	229	91	Mansfield (S)	*	†
Banyule (C)	279	89	Maribyrnong (C)	309	139
Bass Coast (S)	58	68	Maroondah (C)	143	51
Baw Baw (S)	47	39	Melbourne (C)	483	113
Bayside (C)	133	53	Melton (C)	75	23
Benalla (RC)	7	†	Mildura (RC)	27	20
Boroondara (C)	316	71	Mitchell (S)	16	16
Brimbank (C)	146	29	Moira (S)	21	29
Buloke (S)	5	†	Monash (C)	181	37
Campaspe (S)	31	34	Moonee Valley (C)	250	81
Cardinia (S)	91	40	Moorabool (S)	24	30
Casey (C)	152	21	Moreland (C)	745	169
Central Goldfields (S)	*	†	Mornington Peninsula (S)	217	54
Colac-Otway (S)	9	†	Mount Alexander (S)	*	†
Corangamite (S)	5	†	Moyne (S)	17	43
Darebin (C)	561	142	Murrindindi (S)	13	37
East Gippsland (S)	49	43	Nillumbik (S)	95	61
Frankston (C)	156	46	Northern Grampians (S)	5	†
Gannawarra (S)	*	†	Port Phillip (C)	272	94
Glen Eira (C)	214	58	Pyrenees (S)	5	†
Glenelg (S)	6	†	Queenscliff (B)	5	†
Golden Plains (S)	18	35	South Gippsland (S)	13	18
Greater Bendigo (C)	103	38	Southern Grampians (S)	21	53
Greater Dandenong (C)	91	23	Stonnington (C)	222	75
Greater Geelong (C)	174	29	Strathbogie (S)	5	†
Greater Shepparton (C)	123	79	Surf Coast (S)	24	33
Hepburn (S)	14	36	Swan Hill (RC)	16	32
Hindmarsh (S)	*	†	Towong (S)	*	†
Hobsons Bay (C)	307	133	Wangaratta (RC)	74	105
Horsham (RC)	47	98	Warrnambool (C)	83	99
Hume (C)	127	26	Wellington (S)	76	71
Indigo (S)	17	43	West Wimmera (S)	0	0
Kingston (C) (Vic.)	141	36	Whitehorse (C)	217	51
Knox (C)	220	55	Whittlesea (C)	129	26
Latrobe (C) (Vic.)	130	71	Wodonga (C)	97	101
Loddon (S)	5	†	Wyndham (C)	182	35

*Cases less than five are suppressed; †rates for cases less than ten are suppressed.

Hospital admissions for each LGA by place of residence and rate per 100,000 population for adult on-road cyclists injured between 2015/16 to 2017/18 are summarised in Figure 22, Figure 23 and Table 17. The findings illustrate the greatest number of on-road cyclist hospital admissions were from residents of Moreland City Council (n = 385), the City of Port Phillip (n = 374) and Darebin City Council (n = 307). Hospital admission rates by LGA of residents per 100,000 population were highest for the Borough of Queenscliff (153 per 100,000), the City of Port Phillip (129, per 100,000) and the City of Stonington (97 per 100,000).

Figure 22

Number of Hospital Admissions in Relation to Adult On-Road Cyclist Injuries in 2015/16 To 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence

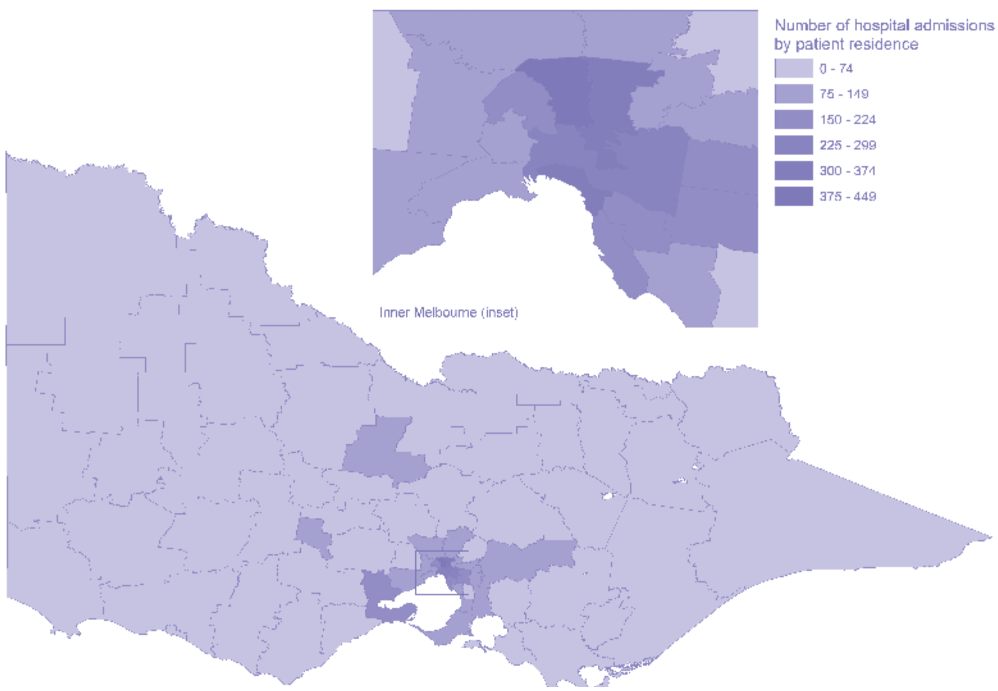


Figure 23

Rate (Per 100,000 Population) of Hospital Admissions in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence

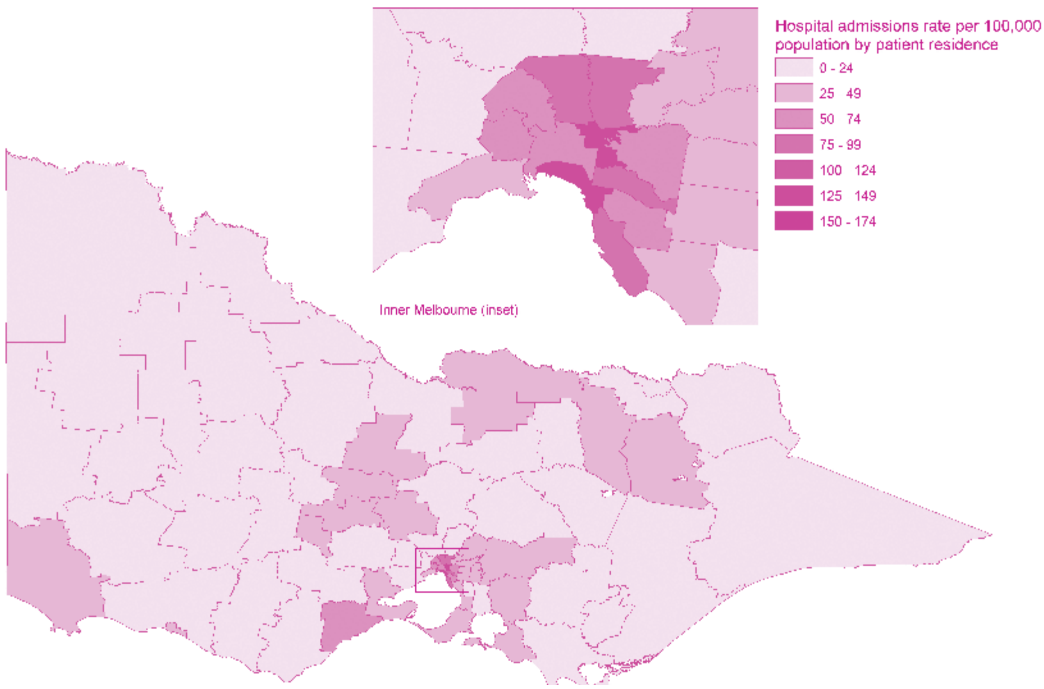


Table 17

Table Overview of Hospital Admissions in Relation to Adult On-Road Cyclist Injuries in 2015/16 to 2017/18 (Three Financial Years), Victoria. Mapping is Based on the Injured Person's Area of Residence

Local Government Area	Summed Attendances*	Attendances per 100,000 Population†	Local Government Area	Summed Attendances*	Attendances per 100,000 Population†
Alpine (S)	11	35	Macedon Ranges (S)	47	41
Ararat (RC)	0	0	Manningham (C)	81	26
Ballarat (C)	83	33	Mansfield (S)	*	†
Banyule (C)	146	46	Maribyrnong (C)	128	58
Bass Coast (S)	29	34	Maroondah (C)	86	31
Baw Baw (S)	20	17	Melbourne (C)	265	62
Bayside (C)	202	80	Melton (C)	40	12
Benalla (RC)	6	†	Mildura (RC)	17	13
Boroondara (C)	296	67	Mitchell (S)	13	13
Brimbank (C)	80	16	Moira (S)	26	36
Buloke (S)	*	†	Monash (C)	150	31
Campaspe (S)	14	15	Moonee Valley (C)	170	55
Cardinia (S)	62	27	Moorabool (S)	8	†
Casey (C)	129	17	Moreland (C)	385	88
Central Goldfields (S)	0	0	Mornington Peninsula (S)	142	35
Colac-Otway (S)	7	†	Mount Alexander (S)	15	31
Corangamite (S)	8	†	Moyne (S)	8	†
Darebin (C)	307	78	Murrindindi (S)	7	†
East Gippsland (S)	19	17	Nillumbik (S)	61	39
Frankston (C)	143	42	Northern Grampians (S)	7	†
Gannawarra (S)	5	†	Port Phillip (C)	374	129
Glen Eira (C)	196	53	Pyrenees (S)	*	†
Glenelg (S)	15	30	Queenscliff (B)	12	153
Golden Plains (S)	10	19	South Gippsland (S)	12	17
Greater Bendigo (C)	107	39	Southern Grampians (S)	8	†
Greater Dandenong (C)	67	17	Stonnington (C)	285	97
Greater Geelong (C)	219	37	Strathbogie (S)	9	†
Greater Shepparton (C)	62	40	Surf Coast (S)	39	53
Hepburn (S)	10	25	Swan Hill (RC)	*	†
Hindmarsh (S)	*	†	Towong (S)	0	0
Hobsons Bay (C)	104	45	Wangaratta (RC)	30	43
Horsham (RC)	*	†	Warrnambool (C)	29	34
Hume (C)	77	16	Wellington (S)	19	18
Indigo (S)	5	†	West Wimmera (S)	0	0
Kingston (C) (Vic.)	136	34	Whitehorse (C)	182	43
Knox (C)	110	28	Whittlesea (C)	85	17
Latrobe (C) (Vic.)	44	24	Wodonga (C)	*	†
Loddon (S)	5	†	Wyndham (C)	91	17

*Cases less than five are suppressed; †rates for cases less than ten are suppressed.

HELMET USE

Ambulance data included variables relating to helmet use and observations regarding the state of the helmet after the injury event. Information in this category was available for 32.8% (n=1627) of records, bearing in mind that this data is not mandatory for paramedics to record. A helmet was recorded as "Worn – INSITU" or "Worn – Removed" for 92.5% (n=1505) of these cyclists, with a further 2% recorded as "Not worn" and an even smaller proportion not known (1.3%). For those noted as wearing a helmet, 30.8% were observed to be damaged in some way.

CYCLIST GROUP RIDING

Group riding (or bunch riding) incidents were identified in ambulance attendance data via text search for up to 18 different terms and phrases such as "pack riding", "riding group", "cycling in a group" or "fellow riders". This approach yielded 136 records, representing 3% of all ambulance attendances.

Males accounted for 83.1% of cyclists riding in groups while those aged 45+ years represented 69.8%. Just below two-thirds (64.7%) of ambulance attendances occurred in the Melbourne Metropolitan area with 90.4% of attendances resulting in a transfer to hospital. Most common injury flags were for fractures (36.8%), bruising/haematomas (33.8%), blunt head injury (25.7%) and lacerations (20.6%). Cyclists could have more than one of these injury flags recorded to have occurred. Ambulance attendances on weekends accounted for 52.2% of group riding-related injuries with the warmer months (January to March) also representing slightly higher proportions (12.5%, 11.8% and 11.0%, respectively). Residents of bayside municipalities were commonly recorded in the sub-group: City of Frankston (11.8%), City of Bayside (11.0%) and City of Boroondara (11.0%). The most common municipality for ambulance attendance for this sub-set was City of Bayside (13.2%), followed by City of Kingston (6.6%) and City of Melbourne (6.6%).

Looking closely at descriptive text for each record revealed that incidents involving another vehicle such as a car or truck were noted in 22.8% of records. As expected, the majority involved collisions or incidents with other riders. Common scenarios within this sub-group included (can include more than one per case):

- Clipping the wheel of the rider in front of them 28.7%, n=39)
- Colliding with other riders – not further described (20.6%, n=28)
- Crashing into or impacting riders who have fallen in front of them (16.2%, n=22)
- Crash causing them to go over the bike's handlebars (15.4%, n=21)
- Being clipped by the rider behind them (6.6%, n=9)
- Car from behind or pulled out in front of (5.9%, n=8)

MALE CYCLISTS AGED 45+ YEARS

Male cyclists aged 45 years and above, colloquially referred to as *Middle Aged Men in Lycra* or *MAMILs*, accounted for 1634/4960 (33%) of total cyclist ambulance attendances, 2621/9640 (27%) of ED presentations and 2178/6301 (35%) of hospital admissions. In contrast, female cyclists aged 45 years and above accounted for 436/4960 (9%) of total cycling ambulance attendances, 751/9640 (8%) of ED presentations and 636/6301 (10%) of hospital admissions. The following data sources have been used to determine the circumstances of cycling injuries in this demographic: day and place were determined using ambulance attendances; cause of the injury and injury type were analysed using admissions data, and ambulance attendances and ED narratives were analysed to determine particular circumstances and settings of the incident.

Injury Location Hotspots

Almost three-quarters (73.2%) of ambulance attendances occurred in Melbourne Metropolitan areas. Looking at Local Government Areas (LGAs): injured cyclists residing in the City of Frankston represented 10.6% ambulance attendances, followed by residents of the City of Bayside (9.5%) and the City of Boroondara (9.4%). Actual LGA ambulance attendance most commonly occurred in the City of Melbourne (10.8%), followed by the City of Bayside (7.2%) and the City of Boroondara (5.4%).

Day of Injury

Ambulance attendances occurred more frequently on weekends, especially Saturdays (18.7%) followed by Sundays (17.9%), while weekdays ranged between 10.3%-14.1%. The warmer months of the year saw a seasonal peak in ambulance attendances with March representing 11.7% and February representing 10.0%. Another spike was observed in the month of October (9.9%), perhaps coinciding with major cycling events such as Melbourne's "Around the Bay in a Day" and Australia's "National Ride 2 Work Day". The lowest proportions of attendances occurred in July (5.7%) and August (5.4%).

Injury Type

Hospital admissions for on-road cyclist injury among males aged 45 years and above (vs. all others) were more likely to be serious injuries. In this group, 21.6% of injuries were severe injuries, as indicated by ICISS score of less than 0.941 (Stephenson et al., 2003). Fractures were relatively common (61% vs. 54%, for males aged 45+ years vs. all others), as were intracranial injury (7.2% vs. 5.6%). Among males aged 45+ years, the main injury was relatively unlikely to be an open wound (7.8% vs. 11.2% in all others) or superficial injury (6.5% vs. 9.0% in all others). Table 18 shows the ten most common principal diagnoses for hospital admissions among cyclists, for males aged 45 years and above vs. all other cyclists. The injury diagnosis profile for males aged 45+ years differed to that of other cyclists: upper arm and shoulder fractures were relatively common, as were rib/sternum/thoracic spine fractures and intracranial injuries.

Table 18

Top Ten Principal Diagnoses for Cyclist Injury Resulting in Hospital Admission Among Males Aged 45+ Years Vs. All Others

		Males Aged 45+ Years		All Others		Total	
	Principal Diagnosis (ICD-10-AM code)	N	%	N	%	N	%
1	Fracture of Shoulder and Upper Arm (S42)	376	17.3	569	13.8	945	15.0
2	Fracture of Forearm (S52)	167	7.7	579	14.0	746	11.8
3	Intracranial Injury (S06)	157	7.2	230	5.6	387	6.1
4	Fracture at Wrist and Hand Level (S62)	109	5.0	271	6.6	380	6.0
5	Fracture of Skill and Facial Bones (S02)	111	5.1	240	5.8	351	5.6
6	Fracture of Rib(s), Sternum and Thoracic Spine (S22)	202	9.3	132	3.2	334	5.3
7	Fracture of Lower Leg, Including Ankle (S82)	75	3.4	231	5.6	306	4.9
8	Open Wound of Head (S01)	74	3.4	230	5.6	304	4.8
9	Fracture of Lumbar Spine and Pelvis (S32)	106	4.9	86	2.1	192	3.1
10	Fracture of Femur (S72)	118	5.4	49	1.2	167	2.7
	All Other Diagnoses	683	31.3	1506	36.5	2189	34.7
	Total	**2178**	**100**	**4123**	**100**	**6301**	**100**

As mentioned previously, in the ambulance attendance data, injury type and bodily region are not recorded in formats similar to those used in the Emergency Department and hospital admissions data. Injury types in the ambulance data are not ICD-10-AM coded due to the lack of diagnostic imaging resources available in the prehospital setting but certain injury types are flagged; however, multiple flags can occur within one case. Establishing mutually exclusive injury type categories would involve adding a hierarchy and therefore introducing potential errors in interpretation. Instead, the number of cases with key injury types are listed as follows:

- Suspected spinal cord injury, n=25 (1.5%)
- Blunt abdominal injury, n=17 (1.0%)
- Blunt chest injury, n=94 (5.8%)
- Blunt pelvis injury, n=91 (5.6%)
- Blunt head injury, n=305 (18.7%)
- Bruising/haematoma, n=368 (22.5%)
- Fracture, n=405 (24.8%)
- Laceration, n=359 (22.0%)
- Soft tissue injury, n=82 (5.0%)
- Wound puncture, n=29 (1.8%)

Please note that these are *not mutually exclusive* categories and cases could have more than one of the above listed injury types. Only 68% of these cases had one of these listed injury types flagged in the ambulance data; 37% had one of these injury types; 21% had two injury types flagged and the remaining 10% had three or more.

A large majority (86.3%) of ambulance attendances resulted in the cyclist being transported to hospital. The remaining attendances resulted in the patient being transferred to hospital via other means such as air ambulance or MICA road team (1.8%), or being referred to a local GP or other health care provider (1.2%), or instances where the patient refused to be taken to hospital (4.3%).

Cause of Injury

There were no marked differences between injury cause among males aged 45+ years and other cyclists: most common in both groups were non-collision transport accidents (44.7% and 43.7%) followed by collision with car, pick-up truck or van (22.5% vs. 25.4%) and other and unspecified transport accidents (16.8% and 17.8%). Collision with other pedal cycles, however, were relatively common among males aged 45 years and above (8.0% vs. 4.7%).

Although there is no specific coding in ambulance data to distinguish between various external cause types, detailed narrative descriptions allowed for grouping of data with common terms. Extensive searches were conducted for vehicle types involved in injury events in the dataset. Terms included “car”, “ute”, “4WD”, “Tram”, etc. A vehicle was identified in just over half of the dataset (56.7%) with cars (including utes, and SUV-type vehicles) mentioned in 32.9% of narrative descriptions, followed by trucks (17.5%) and trams/tram tracks (3.4%). The term “collision or collided with” was mentioned in 9.8% of records, “clipped” mentioned in 7.2% and “struck/hit” in 11.0%.

Circumstances and Setting

Ambulance attendance data reported the presence or use of alcohol in 4.3% of records, while less than 1% noted the presence or use of drugs. A small proportion (3.4%) were noted to be cycling to or from work. Incidents involving roundabouts were frequently mentioned (6.5%) in case narratives, as were incidents with parked or stationary cars (5.6%) and animals (4.3%) – kangaroos and dogs. Terms to identify incidents involving group riding were applied to the dataset and found to represent 5% (n=81) of these records. Common scenarios within this sub-group included (can include more than one per record):

- Colliding with other riders – not further described (22.2%, n=18)
- Clipping the wheel of the rider in front of them (18.5%, n=15)
- Crashing into or impacting riders who have fallen in front of them (12.3%, n=10)
- Crash causing them to go over the bike’s handlebars (12.3%, n=10)
- Being clipped by the rider behind them (11.1%, n=9).

Ambulance data included variables relating to helmet use and observations regarding the state of the helmet after the injury event. Information in this category was available for 28.7% (n=469) of records. A helmet was recorded as “Worn – INSITU” or “Worn – Removed” for 95.5% (n=448) of these cyclists, with a further 1% recorded as “Not worn” and an even smaller proportion not known (1%). For those noted as wearing a helmet, 39.7% were observed to be damaged in some way.

CYCLIST INJURY TRENDS (10 YEARS)

Ten-Year Trends in Adult On-Road Cyclist Injury (2008/09-2017/18)

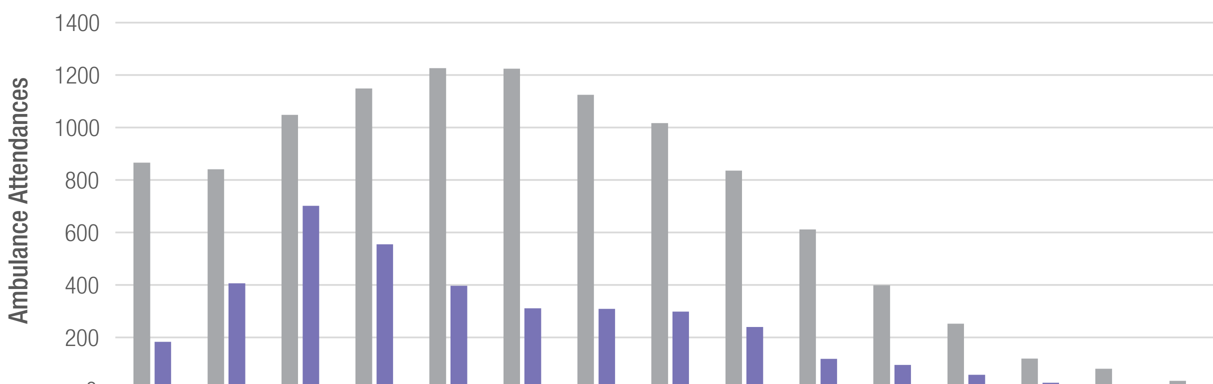
In the ten-year period from 2008/9 to 2017/18, there were 14,546 ambulance attendances (an average of 1,455 per year), 32,015 Emergency Department presentations (an average of 3,202 per year) and 17,496 hospital admissions (an average of 1,750 per year) in relation to on-road cyclist injury in Victoria. An overview of the frequencies, population-based rates and trends are given in the tables and figures below; these are described in more detail in the following sections: Ambulance attendances; ED presentations; and Hospital admissions.

Ambulance Attendances

An overview of ambulance attendances related to on-road cyclist injury for males and females, by age group, is shown in Figure 24. Among males, ambulance attendances were most common in the age group 35-39 years, closely followed by 40-44 years. Among females, bicycle injury-related ambulance attendances were most common in the age group 25-29 years, followed by 30-34 years. The overall male to female ratio as 2.9:1; the ratio was most skewed in the age groups 80-84 years (5.7:1), 60-64 years (5.2) and 15-19 years (4.7:1) and least skewed in the 25-29 year age group (2.5:1).

Figure 24

Ten Years of Cyclist Injury Ambulance Attendances in Victoria, 2008/09 to 2017/18: Frequencies by Age Groups and Sex

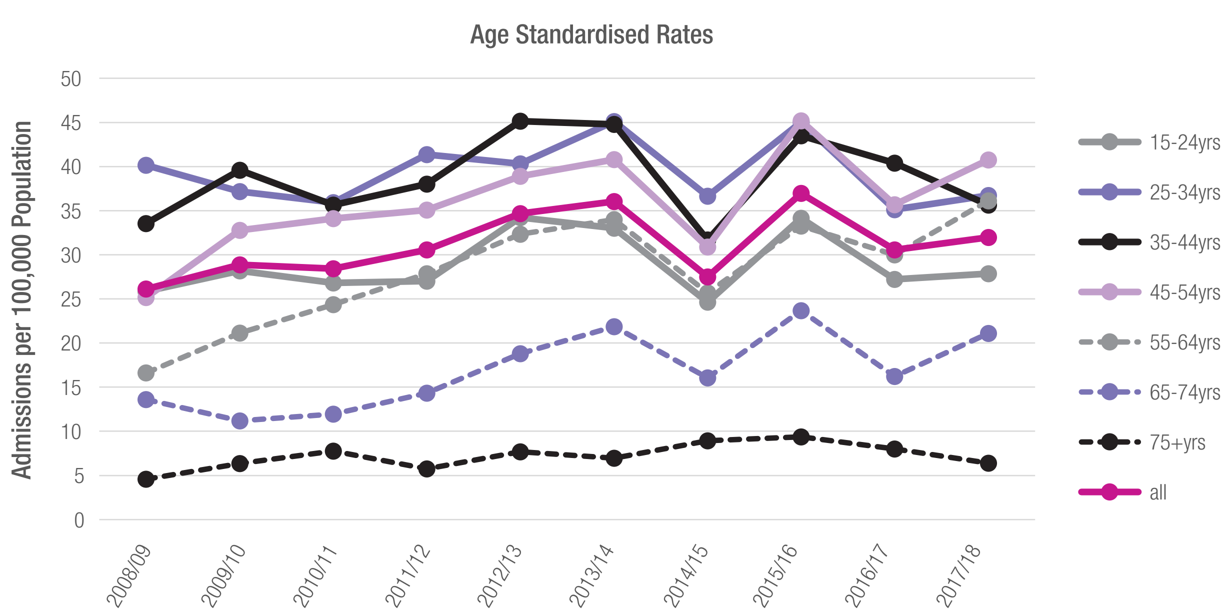


	15-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	65-69 years	70-74 years	75-79 years	80-84 years	85+ years
Males	866	841	1048	1149	1226	1224	1125	1017	836	611	399	252	119	80	34
Females	183	406	702	555	397	311	309	298	239	118	95	57	27	14	8

The age standardised rates of cyclist ambulance attendances for the ten-year period 2008/09 to 2017/18 are shown in Figure 25; the results are shown per age group and overall. Statistical analysis of the population-based rates and trends in cyclist-related ambulance attendances are summarised in Table 19. The average age-standardised annual rate over the ten-year period was 31 ambulance attendances per 100,000 population. The cyclist injury related ambulance attendance rate increased statistically significantly by 2.0% per year. An increase was observed among both males (1.9%) and females (2.2%). Statistically significant increases were observed for females in the age groups 45-64 years, and for males in the ages 45-74 years. The greatest *rate increases* were observed in males aged 55-64 and 65-74 years (6.1 and 7.5% per year, respectively) followed by females aged 55-64 years (6.0%).

Figure 25

Ten Years of Cyclist Injury Ambulance Attendances in Victoria, 2008/09 to 2017/18: Age Standardised Rates by Age Group



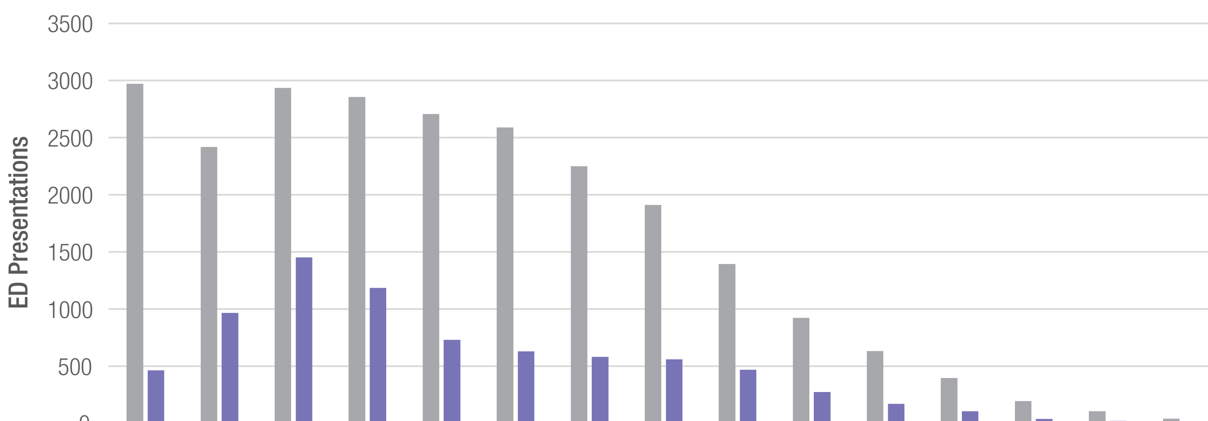
IN VICTORIA, FOR THE PERIOD 2015/16 TO 2017/18, HOSPITAL TREATMENT COSTS (DIRECT & INDIRECT) FOR ADULT ON-ROAD CYCLIST INJURY ADMISSIONS TOTALLED $41.3 MILLION; MALES AGED 35-64 YEARS ACCOUNTED FOR 45% OF HOSPITAL ADMISSION COSTS AT $18.6 MILLION.

Emergency Department Presentations

The profile of Emergency Department presentations related to on-road cyclist injury for males and females, by age group, is shown in Figure 26. Among males, ED presentations were most common in the age group 15-19 years, followed by 25-29 years. Among females, ED presentations were most common in the age group 25-29 years, followed by 30-45 years. The overall male to female ratio as 3.2:1; the ratio was most skewed in the age group 15-19 years (6.4:1) and least skewed in the 25-29 year age group (2.0:1).

Figure 26

Ten Years of Cyclist Injury ED Presentations in Victoria, 2008/09 to 2017/18: Frequencies by Age Groups and Sex



	15-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	65-69 years	70-74 years	75-79 years	80-84 years	85+ years
Males	2972	2418	2937	2857	2707	2589	2251	1912	1396	924	634	398	197	108	43
Females	464	968	1453	1186	732	630	583	561	470	276	172	107	39	22	9

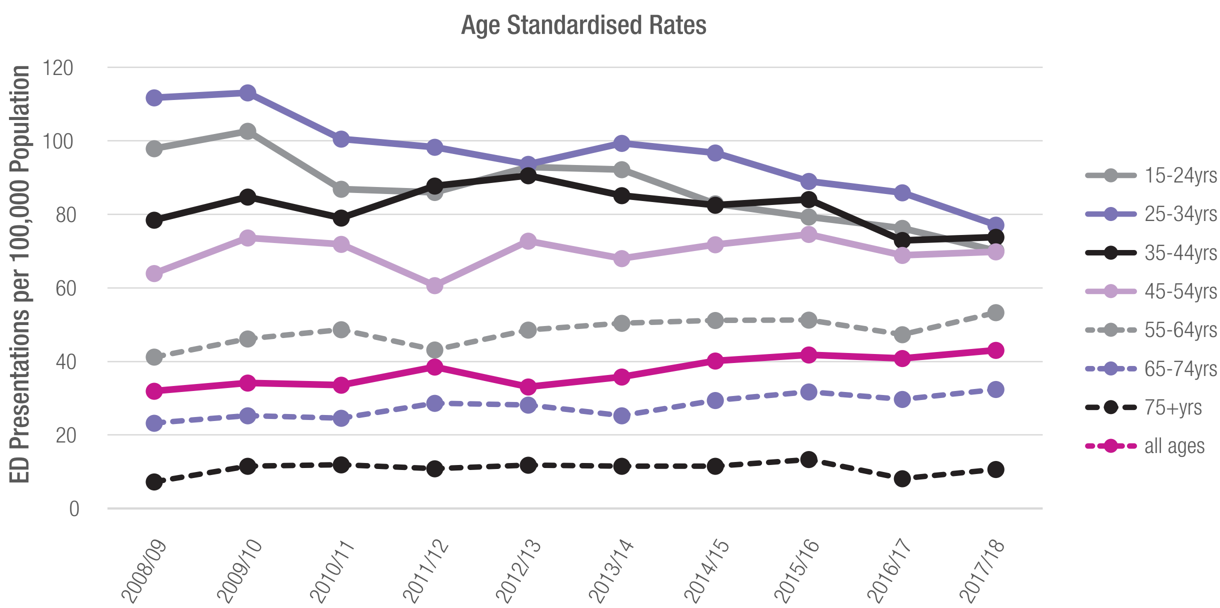
MALE CYCLISTS AGED 45 YEARS AND ABOVE, COLLOQUIALLY REFERRED TO AS *MIDDLE AGED MEN IN LYCRA OR MAMILS*, ACCOUNTED FOR 33% OF TOTAL CYCLIST AMBULANCE ATTENDANCES, 27% OF ED PRESENTATIONS AND 35% OF HOSPITAL ADMISSIONS IN VICTORIA (2015/16 TO 2017/18).

Age standardised rates of cyclist-related ED presentations over the ten-year period 2008/09 to 2017/18 are shown in Figure 27; the results are shown per age group and overall. Statistical analysis of the population-based rates and trends are summarised in Table 19. The average age-standardised annual rate over the ten-year period was 69 ED presentations per 100,000 population. The ED presentation rate decreased statistically significantly by -1.4% per year. A decrease was observed among both males (-1.4%) and females (-1.6%). Statistically significant decreases were observed in the age groups 15-24 years, 25-34 years and 35-44 years (among females only, in this age group). ED presentation rates increased statistically significantly among males aged 55-74 years.

ED presentation rates could be influenced by external (non-injury) influences, such as initiatives to prevent overcrowding in emergency departments through promotion of GP services for non-urgent care. Appendix D provides an overview of ED presentation trends, selecting only cases triaged as urgent. These results suggest an increase in urgent ED presentations due to cycling injuries, during the 10-year period. This is explained further in the Discussion section.

Figure 27

Ten Years of Cyclist Injury Related ED Presentation in Victoria, 2008/09 to 2017/18: Age Standardised Rates by Age Group

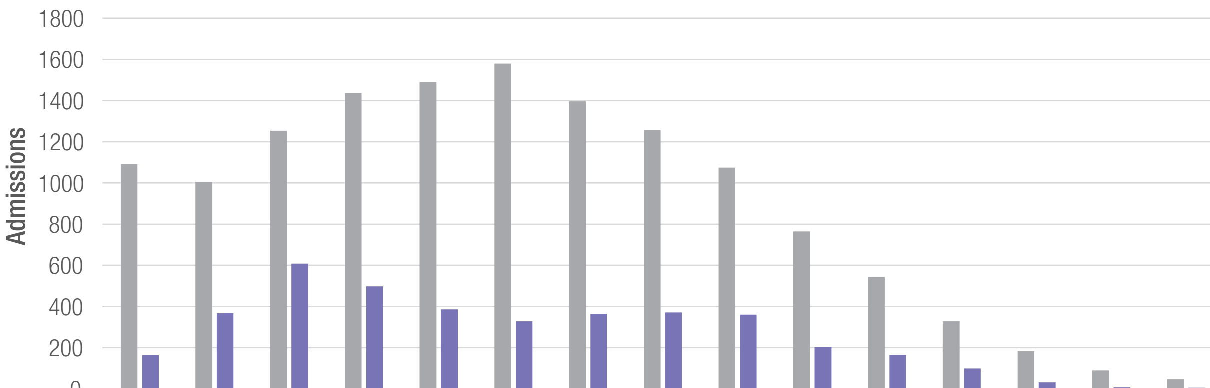


Hospital Admissions

The hospital admissions profile related to on-road cyclist injury for males and females, by age group, is shown in Figure 28. Among males, hospital admissions were most common in the age group 40-44 years, followed by 35-39 years. Among females, hospital admissions were most common in the age group 25-29 years, followed by 30-34 years. The overall male to female ratio was 3.4:1; the ratio was most skewed in the age groups 80-84 years (11.1:1), 85+ years (7.7:1) and 15-19 years (6.7:1) and least skewed in the 25-29 year age group (2.1:1).

Figure 28

Ten Years of Cyclist Injury Related Hospital Admissions in Victoria, 2008/09 to 2017/18: Frequencies by Age Groups and Sex



	15-19 yrs	20-24 yrs	25-29 yrs	30-34 yrs	35-39 yrs	40-44 yrs	45-49 yrs	50-54 yrs	55-59 yrs	60-64 yrs	65-69 yrs	70-74 yrs	75-79 yrs	80-84 yrs	85+ yrs
Males	1092	1005	1254	1436	1489	1580	1396	1256	1074	764	544	328	183	89	46
Females	164	367	608	498	386	328	364	371	361	203	165	99	32	8	6

HOSPITAL ADMISSIONS FOR ON-ROAD CYCLIST INJURY AMONG MALES AGED 45 YEARS AND ABOVE (VS. ALL OTHERS) WERE MORE LIKELY TO BE SERIOUS INJURIES.

For the ten-year period 2008/09 to 2017/18, age standardised rates of cyclist-related hospital admissions are shown in Figure 29; the results are shown per age group and overall. Statistical analysis of the population-based rates and trends in cyclist-related hospital admissions are summarised in Table 19. The average age-standardised annual rate over the ten-year period was 37 hospital admissions per 100,000 population. The hospital admissions rate increased statistically significantly by 3.4% per year. An increase was observed among both males (3.3%) and females (3.7%). Statistically significant increases were observed for females in the age groups 45-74 years, and for males in all age groups 35 years and above. The greatest *rate increases* were observed in males aged 55-74 years (7.7% per year) followed by females aged 65-74 years (7.3%). These rate changes may have been influenced by the Victorian hospital admission change in 2012, as further explained in the Discussion section. Appendix C provides an overview of *overnight hospital admission* rates, which are less sensitive to the policy change: these results further support the finding that cyclist admissions increase in the ten-year period.

Figure 29

Ten Years of Cyclist Injury Hospital Admissions in Victoria, 2008/09 to 2017/18: Age Standardised Rates by Age Group

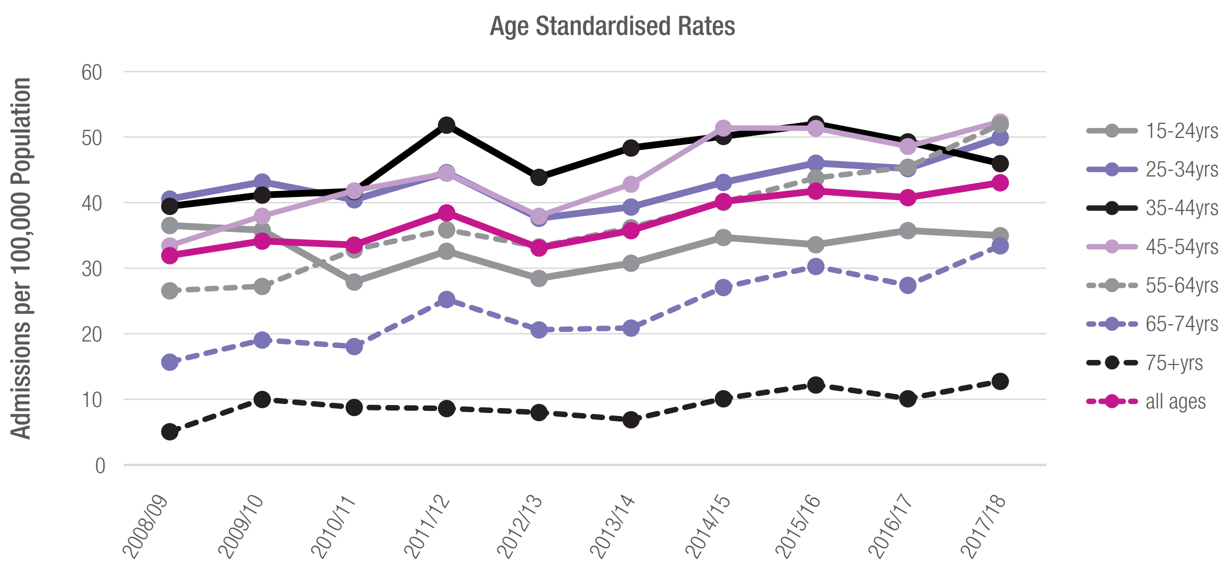


Table 19

Ten-Year Trends in Cyclist Injury, Victoria 2008/9 to 2017/18: Age-Standardised Rates*

	Ambulance Attendances		Emergency Department Presentations	
	Average annual rate* (attendances per 100,000 population)	Annual change in rate (%)	Average annual rate* (presentations per 100,000 population)	Annual change in rate (%)
Male				
15-24 years	42.5	+0.2 [-2.2, +2.6]	135.6	-3.7 [-4.8, -2.5]
25-34 years	50.5	-0.3 [-2.3, +1.7]	133.6	-3.7 [-4.5, -2.9]
35-44 years	60.9	+0.3 [-1.9, +2.5]	131.8	-0.7 [-2.0, +0.6]
45-54 years	56.9	+3.0 [+1.0, +5.0]	110.8	+0.5 [-0.8, +1.8]
55-64 years	45.4	+6.1 [+3.4, +8.9]	73.5	+2.4 [+0.6, +4.2]
65-74 years	28.3	+7.5 [+3.7, +11.5]	45.4	+3.4 [+1.7, +5.2]
75 and above	14.8	+3.2 [-1.3, +7.9]	22.5	+1.5 [-2.3, +5.3]
Total (male)	47.5	+1.9 [+0.9, +2.9]	108.0	-1.4 [-2.0, -0.8]
Female				
15-24 years	14.9	+2.3 [-0.5, +5.2]	36.4	-2.1 [-3.8, -0.4]
25-34 years	28.5	+0.1 [-2.2, +2.4]	60.4	-3.1 [-4.5, -1.7]
35-44 years	17.2	+1.7 [-1.1, +4.6]	33.2	-2.0 [-3.6, -0.4]
45-54 years	15.5	+5.2 [+1.4, +9.2]	29.3	+0.7 [-1.5, +2.9]
55-64 years	10.8	+6.0 [+0.4, +11.9]	22.7	+0.9 [-1.8, +3.6]
65-74 years	6.4	+0.1 [-6.9, +7.6]	11.6	+2.6 [-1.6, +7.0]
75 and above	2.3	+3.7 [-6.2, +14.8]	3.4	N/A
Total (female)	15.6	+2.2 [+0.8, +3.6]	32.3	-1.6 [-2.3, -0.8]
Grand total	**31.2**	**+2.0 [+0.9, +3.0]**	**69.3**	**-1.4 [-2.1, -0.7]**

*Age standardised to the 2011 standard population

Hospital Admissions	
Average annual rate* (admissions per 100,000 population)	Annual change in rate (%)
52.3	+0.1 [-1.9, +2.2]
61.6	+1.5 [-0.2, +3.2]
76.1	+2.4 [+0.8, +4.0]
70.4	+4.0 [+2.5, +5.5]
57.6	+7.7 [+5.7, +9.8]
37.8	+7.7 [+5.1, +10.3]
20.3	+6.2 [+1.9, +10.6]
59.2	+3.3 [+2.5, +4.1]
13.4	+1.8 [-1.4, +5.2]
24.9	+2.9 [-0.3, +6.2]
17.4	+1.0 [-2.3, +4.4]
18.7	+6.1 [+3.9, +8.3]
17.0	+5.8 [+2.8, +8.8]
10.8	+7.3 [+2.4, +12.6]
2.2	N/A
16.4	+3.7 [+2.5, +4.9]
37.3	**+3.4 [+2.6, +4.2]**

DISCUSSION

Main Findings from the Most Recent Three Years

In the three-year period from 2015/16 to 2017/18, there were 9,640 Emergency Department presentations, 6,301 hospital in-patient admissions and 4,960 on-road cyclist injuries attended by paramedics. Male cyclists represented the majority of ED presentations (75.6%), hospital admissions (77.0%) and injuries attended by paramedics (74.1%).

On-road cyclists aged between 25 and 34 years were the most commonly injured age group. The median age of injured cyclists was relatively consistent across data sources, ranging from 34 to 42 years. Interestingly, the median age of injured female cyclists was consistently lower than males.

The discrepancy in the age and gender profile of injuries likely represent a combination of factors that influence cycling participation and exposure. Nationally, males exhibit higher rates of participation in cycling than females (Austroads, 2019), with higher rates of both recreation and transport cycling (Heesch, K. C. et al., 2012a).

Research by Fishman et al. (2012) posits that female cyclists express greater safety concerns when riding a bicycle with motorised vehicles. This risk mitigation has been demonstrated in a number of Melbourne based studies which have identified that female cyclists are more likely to ride off-road, compared to males who have an increased likelihood of riding on-road (Garrard, J. et al., 2008; Heesch, K. C. et al., 2012a).

There are also differences in travel patterns between genders that may influence cycling participation. Compared to males, females have been shown to exhibit more complex patterns of travel, with increased trip chaining, due to increased obligations including employment, household work and caregiving (Scheiner & Holz-Rau, 2017). Furthermore, Currie and Delbosc (2011) demonstrated that in Melbourne the majority of multiple purpose trips are undertaken by car, with only five percent of multi-stop trips being performed by bicycle. These patterns may indicate decreased exposure to cycling injuries for females in Melbourne. Conversely, males have a greater propensity for risk taking behaviours compared to female cyclists (Cobey et al., 2013) and are also more likely to demonstrate aggressive behaviours while cycling, which are associated with increased crash risk (Stephens et al., 2019) and may contribute to their overexposure.

Cyclist injuries were observed to follow a seasonal pattern. The lowest rates of trauma were reported in winter months, with peaks observed in March. The finding is consistent with previous research, where winter cycling is generally less common (Pucher, J. et al., 2010). Across the week, the pattern of injury is likely a reflection of increased exposure on weekends, with higher rates of recreational cycling occurring. In this edition of Hazard, injury patterns cannot be disaggregated into bicycle riding participation (exposure) and trends in relative injury risk. The observed time-patterns could result from either or both of these.

To gain a better understanding of the geographic patterns of injury, ambulance attendance data was compared with residential location information based on Local Government Areas. The analysis identified a number of trends regarding locations with increased incidence and risk of injury. Ambulance attendance data identified that the highest incidence of on-road cyclist injury occurred in the City of Melbourne, followed by Bayside City Council, Darebin City Council and the City of Greater Geelong. These are all locations with typically high proportions of commuter and recreational cyclists. The high proportion of ambulance attendances in the City of Melbourne likely reflects commuter cyclists travelling to the city. Notwithstanding, when considering location of residence, the City of Melbourne had the highest incidence and rate of injuries. These figures are likely a reflection of the high cycling mode share in the City, but also reflect the need for improved safety for cyclists in this area.

Outside of the inner city, Geelong and Bayside are both popular recreational cycling locations. Previous investigations of the Bayside cycling corridor by Lawrence et al. (2015) and Johnson et al. (2009) identified how infrastructure interventions and behaviour change programs, through the introduction of a cycling Code of Conduct, have helped to reduce injuries and improve cyclist behaviour. Similar interventions could be investigated for other locations throughout Victoria that are popular with recreational and group-riding. Examination of ED presentations and hospital admissions by place of residence identified that the highest proportion of injured cyclists tended to live in inner urban areas. This is likely a reflection of the increased cycling mode share in these locations and associated exposure.

For hospital admitted cyclists, the majority of injuries were sustained while cycling in traffic. Interestingly, almost half of admitted cyclists were not injured in a collision. The findings align with previous research undertaken by Boufous et al. (2013), who identified that over half of hospitalisations for on-road bicycle crashes do not involve another road user, with over 80 percent resulting from the cyclist losing control of their bicycle. Beck et al. (2016) found similar proportions of single bicycle crashes in their in-depth investigation of cyclist trauma and identified that while cyclists may not have impacted another road user, interactions preceding the crash may have contributed to the loss of control. Furthermore, Beck et al. (2016) identified issues with path surface condition and debris as contributing factors to single bicycle crashes. In a follow up study Beck et al. (2019b) further identified tram tracks and mechanical issues as contributing factors, in line with the causal factors identified by paramedics, as summarised in this research.

When another road user was involved, the most common collision counterparts were light vehicles, including cars, pick-ups and vans, representing 24% of hospital admissions. These were also the most commonly reported counterparts amongst ambulance attended cases. Very few injuries were reported for cyclists due to collisions with pedestrians. These findings were in line with previous research reported by O'Hern and Oxley (2019), that investigated pedestrian injuries due to cyclists. A notable extension in this issue of Hazard are the findings from ambulance attended cases where pedestrians were identified in text narratives in only 2.4% of cases. However, analysis of pedestrian injury in Ambulance Victoria data will be required to gain full understanding of the harm from cyclist-pedestrian collisions. Given the multitude of shared pathways in Victoria, this research is pertinent to planning improvements in infrastructure that keeps all vulnerable road users safe.

A number of collisions between cyclists were also identified in ambulance attended cases, particularly for those engaging in group riding. Interestingly, there was an increased risk of these collisions amongst males aged 45 years and older, with collision mechanisms including clipping or being clipped by other riders and crashing into riders who have fallen in front of them.

There are noted limitations with the use of ambulance narratives; however, the findings do provide insight regarding common cycling injury mechanisms including collisions with parked and stationary cars, being struck by a car-door and collisions with vehicles turning in and out of the roadway.

Utilising naturalistic cycling techniques, Johnson et al. (2013), identified that while car-door related injuries are relatively rare, the exposure to door-related events are fairly common and were found to occur at a rate of 0.59 events per trip. Beck et al. (2016) identified a high number of collisions between cyclists and motor vehicles, when the motorist was turning either left or right at intersections.

Across the examined nonfatal cases, there was a vast range of trauma. There were numerous accounts of major trauma including spinal cord, intracranial and internal organ injuries. The most common injuries were bruising, lacerations, fractures and sprains. Not surprisingly, overall, cyclists admitted to hospitals tended to suffer from more severe injuries than those presenting to the ED. Notably there was a high number of head injuries. Fortunately, high rates of helmet usage were reported by paramedics (when helmet-related information was captured), with previous research highlighting the protective effect of wearing helmets for cyclists (Biegler et al., 2012).

Other risk factors identified for cyclists included the presence of alcohol, which was reported in 4.5% of ambulance cases. Just over half (53%) of cyclists in this category were aged between 25-44 years of age. Approximately 40% occurred on weekends and over the summer period (37%). Collisions with other vehicles accounted for 45% of ambulance attendances in this subset while 11% represented non-collision incidents that occurred at very low speeds (less than 10 km/hr). Twenty-five percent had poor or no recollection of the circumstances of their cycling injury event. Helmets were reported to be worn by 35% of cyclists in this subset. Several cyclists were reported to have been riding to or from the pub, bottle shop, on a “cycling pub crawl” or on a “wine tasting tour”. All this supports the view that alcohol consumption has a detrimental effect on the riders' ability to ride their bike safely, impairs their judgement and the ability to recall how they came to grief. Riders need to be made aware of the dangers of drinking and cycling and the legal ramifications in terms of legal riding BAC limits. The findings indicate the need for further education regarding the risks of cycling and alcohol consumption.

Infrastructure was specifically noted as a contributing factor in very few cases, with the most common issues including roundabouts (5.8%), tram infrastructure (5.3%) and pot holes in the roadway. However, it is possible that these factors are of little concern for attending paramedics and in-depth crash investigations would likely provide better estimates of potential infrastructure issues.

Overall, hospitalised cyclists required 19,953 bed days in Victoria. The majority (65.3%) of hospital stays were less than two days. The length of hospitalisation did not differ significantly by age or gender. The cost of hospitalisation represented approximately $41.3 million AUD in hospital costs for the three-year period. It should be noted that this is only the direct costs associated with in-patient treatment, with the true economic cost to the health system likely to be much higher. Notwithstanding, the findings indicate the significant public health issue associated with adult cyclist on-road trauma.

Main Findings About Trends Over the Past 10 Years

Trends were observed for the ten-year period 2008/09-2017/18. Over this time period, there were 32,015 ED presentations, 17,496 hospital admissions and 14,546 on-road cyclist injuries attended by paramedics in Victoria.

When controlling for population, there was a statistically significant increase in ambulance attended cases of 2% per annum. Furthermore, the increase was observed for male and female cyclists. The greatest increases were observed for adults over 45 years of age and may be indicative of their increased participation in recreational cycling. It could also be associated with the increased frailty of older cyclists, and this may account for their over representation amongst serious injuries compared to younger counterparts (Boufous et al., 2013).

For cyclists presenting to EDs, there was a general downward trend, with an overall statistically significantly decrease of -1.4% per annum. However, while the overall rate of ED presentations decreased, ED cases triaged as "Urgent" (Appendix D) increased by 1.4% per annum for male and female cyclists. This suggests that the decrease in overall ED presentations could possibly be due to external (non-injury related) influences; for example, initiatives to shift non-urgent ED presentations to General Practice, to prevent ED overcrowding.

In the 10-year study period, there was a statistically significant increase in the rate of hospital admissions, which increased by 3.4% per annum. These trends were observed for male and female cyclists. This trend could, however, be influenced by the Victorian hospital admission policy change (Hayman & Berecki-Gisolf, 2019). Since the Victorian Hospital Admission Policy change in July 2012, episodes of care delivered entirely within a designated emergency department or urgent care centre could no longer be categorised as an admission regardless of the amount of time spent in the hospital. This has had the effect of reducing the number of admissions recorded in the VAED, starting in the 2012/13 financial year. Therefore, it is recommended that the hospital admission trends and trend analysis be interpreted with caution, as the observed trend could be influenced by the Victorian Admission policy change in 2012. To better understand underlying trends in hospital admissions, an overview of overnight stay admissions is provided in Appendix C. Same day admissions, which are the most likely to be affected by the Victorian Hospital Admissions policy change in 2012, have been excluded from this analysis. These results support the finding that cyclist hospital admission rates increased over the ten-year period, for both males and females.

Based on this analysis it is not possible to determine if the increase in cyclist trauma is a result of a more dangerous road environment or due to increased rates of participation; in order to answer that question, more comprehensive measures of cyclist exposure are required. Notwithstanding, in absolute terms there is a consistent increase in trauma for cyclists and this represents a growing public health issue, particularly given overall reduction in road trauma for motorised vehicles (State Government of Victoria, 2016). Without further cyclist safety intervention, the current trend is not expected to reverse, given current government strategies such as the *Victorian Cycling Strategy 2018-2028 – Increasing cycling for transport* that seek to promote increased cycling participation.

Findings Within the Context of Current Policy Responses and Policy Implications

The research presented in this issue of Hazard has identified that on-road cyclists are experiencing increased rates of trauma in Victoria. The findings highlight that cyclist trauma is a growing public health issue that is resulting in significant economic costs to the community.

The *Victorian Cycling Strategy 2018-2028 – Increasing cycling for transport* (Transport for Victoria, 2017) seeks to increase cycling as a mode of transportation, particularly amongst under-represented groups that currently may be deterred from cycling due to traffic stress associated with interaction with motor vehicles. The findings from this analysis confirms the high proportion of trauma associated with ambulance attended crashes due to collisions with motor vehicles. Furthermore, collisions with light vehicles were found to account for approximately one-quarter of ED presentations and hospital admissions.

Research has shown that when riding on-road, the passing distances of motorists is a particular issue for cyclists. Beyond collisions that can occur, near passes have the potential to destabilise cyclists, despite there being no physically collision. Recent research in Victoria estimated that motorists pass cyclists with less than one metre of clearance approximately 6% of the time (Beck et al., 2019a). The research further indicated that the presence of on-street motor vehicle parking and some bicycle lane configurations can further reduce the passing distance.

Fundamentally there is a need for safer on-road infrastructure for cyclists. Infrastructure should provide a dedicated right-of-way and separation from passing motorists and parked vehicles, which were both identified as contributing factors to cyclist trauma in this research. Beyond physical infrastructure, currently all states and territories in Australia, with the exception of Victoria, have implemented minimum passing distance road rules or trials. Changes in legislation have been driven by advocacy groups such as the Amy Gillett Foundation. Recently the RACV has recommended that a trial of minimum passing distance rule should be undertaken in Victoria; furthermore, the Victorian Government have recently stated they are reviewing the effectiveness of interstate legislations.

Spatial analysis identified high incidence rates in inner Melbourne. Efforts to lower vehicle speeds and provide dedicated infrastructure for commuter cyclists are likely to reduce trauma in these locations. Furthermore, behaviour change programs for drivers and cyclists engaging in aberrant behaviours could be beneficial, particularly for behaviours such as cycling under the influence of alcohol.

Outside of inner urban and highly pedestrianised areas there is potential for cyclists to utilise footpaths, particularly when riding adjacent to high speed roads with high traffic volumes. This report demonstrates very few cyclists are injured in collisions with pedestrians, while previous research in Victoria has shown low rates of pedestrian injuries (O'Hern & Oxley, 2019). Similar legislation is in place in Queensland, Australia, where cyclists are allowed to ride on road or on the footpath, provided they keep left and give way to pedestrians (Haworth & Schramm, 2011). While this is only appropriate when travelling at low speeds, it may provide a viable option for less experienced riders to cycling in an environment with reduced traffic stress and this could help to promote increased participation. However, there is debate about this option as it still represents a compromise for safety and dedicated cycling infrastructure would be a preferred solution.

Furthermore, this is not appropriate for all cyclists; many cyclists prefer to ride on road, particularly those undertaking recreational or group riding. The spatial analysis demonstrated increased injury rates in locations popular with recreation cycling including Bayside City Council, the City of Greater Geelong and the Alpine Shire Council. In these areas there is a need to facilitate safe on-road cycling. For urban areas this may include removing kerbside parking, restricting vehicle turning movements and ensuring the road surface is maintained and clear of debris. In regional settings popular with on-road cyclists, infrastructure should be provided to support safe cycling (i.e. wide sealed shoulders); road authorities should also include signage along known cyclist routes to increase driver awareness. These could be complimented with driver awareness campaigns.

Fundamentally, there is a need to increase promotion of cycling as a health and environmentally friendly mode of transportation and efforts to reduce on-road trauma and address safety issues, are likely to encourage increased participation. This can be achieved by changing the road environment, infrastructure and behaviour to enable more people to cycle as part of their everyday lives.

Limitations

This edition of Hazard, focussing on on-road adult cycling injuries, has limitations. Some key limitations are outlined below, as well as their impact on the reliability and generalisability of the findings.

Limited Data Sources

The results presented in Hazard do not capture all on-road cyclist injuries in Victoria, but are limited to those that are recorded and coded in the Cause of Death data, hospital admissions data, Emergency Department data, and Ambulance Victoria data. Bicycling injuries that are presented to the General Practitioner only or that do not require medical attention are not captured in this research. The results, therefore, are an underestimate of all on-road cyclist injuries in Victoria, and provide a subset of relatively severe injuries.

Sport or Transport?

Bicycle riding can serve as sport or transport, and bicycle riding can be a leisure activity or work-related (including commuting). Leisure and work can be considered to be separate entities (the definition of leisure is time when one is not working or occupied; free time) but distinguishing between sport and transport is a more difficult matter. Bicycle riding as a form of transport can result from a choice to engage in physical activity (alternative to using a car or public transport): the same journey can therefore be considered to be sport as well as transport. In this edition of Hazard, no distinction was made based on work relatedness, sport, leisure or transport. Case selection, however, was limited to on-road only, mainly to facilitate use of the findings to inform prevention efforts. Preventive measures for on-road bicycle injuries are mostly distinct from those aimed to prevent back-yard, park, mountain track and velodrome bicycle injuries, which require unique preventive efforts.

Place of Injury Occurrence

Geographical location of the injury occurrence is not captured in VISU's core injury surveillance datasets. For cycling injuries, however, location is of particular relevance, to identify hotspots and focus on particular regions for prevention. For this edition of Hazard, Ambulance Victoria data was used to gain insight into cycling injury hot-spots. The mapping clearly shows that place of occurrence is quite distinct from place of residence of the injured cyclist. The location provided, however, is the *ambulance call-out location*, which is not necessarily the place of occurrence. This limitation needs to be acknowledged: particularly for non-severe injuries or injuries with late-onset of symptoms, the cyclist may have completed the journey after the injury occurred, and ambulance attendance could have occurred in a time and place not consistent with the injury occurrence.

Increasing Popularity of Bicycle Riding in Victoria

The most significant limitation that needs to be acknowledged is the lack information on *trends in bicycle riding* in Victoria. The presented trends in on-road bicycle injury in Victoria could be due to a decline in safety for bicycle riders on Victorian roads, or simply due to an increase in bicycle riders on the roads. A combination is also possible; it is also possible that relative safety may have improved but not enough to offset the increase in bicycle riders on Victorian roads. The presented trends in this Hazard do not account for underlying trends in bicycle riding and therefore conclusions cannot be drawn about trends in bicycle safety. The presented trends should be used to inform prevention, in terms of which demographic groups have the greatest burden of bicycle injuries, and trends in the size of the injury problem over time. Conclusions regarding trends in safety or injury risk cannot be drawn without adjusting for trends in bicycle riding over time, by age and sex. Collecting detailed bicycle exposure data, ideally also per location, would make a valuable contribution to further research to inform bicycle injury prevention measures.

RECOMMENDATIONS

The following recommendations are made to relevant road safety and public health agencies in light of the findings from the current study, and cited previous published research:

Policy and Infrastructure Investment Recommendations to Government

1. Greater investment in dedicated bicycling infrastructure, such as cycleways (physically protected cycle lanes), will benefit bicycle safety and is recommended particularly in areas that currently have high rates of on-road bicycle injuries, such as Bayside and Darebin and Melbourne City.	2. Infrastructure investments to accommodate safe on-road cycling in stretches of road that are commonly used by cyclist groups ('group riding') could feature place-specific adaptations such as sealed shoulders and more frequent road maintenance.
3. Lowering vehicle speeds is a pillar of the safe system approach and would also benefit bicycle safety, by reducing the time required for motorists to react in a collision and lowering the kinetic energy if a crash does occur.	4. As the majority of hospital-treated bicycle injuries were single vehicle (no-crash) incidents, it is recommended that roads commonly used by cyclists are well maintained and free of bicycle hazards such as potholes, grates and hazardous drains.

Education

5. As bicycle riding in Victoria is increasing in popularly and *on-road cycling* is common, it is recommended that public awareness and education campaigns, targeted at all road users (including cyclists), promote understanding of road rules (for example reasons for riding two abreast) and respectful sharing of the road.	6. Alcohol involvement was recorded in a subset of bicycle injuries, particularly in crashes. However toxicology is not consistently recorded in the datasets. It is recommended that further research is undertaken, investigating the prevalence of drinking while cycling and the contribution to injury.

Bicycle Research Investment

7.	8.
To better understand bicycling trends and trends in the relative safety of cyclists, it is recommended that current statistics on cycling in Victoria (including off-road) are collected, summarised and analysed. This will also identify gaps in cyclist exposure data that can be addressed in a prospective Victorian cyclist survey. Questions could also be included in the Victorian population health survey to capture bicycle use.	It is recommended that an economic evaluation is carried out of the cost of cyclist injuries, taking into account cost saving due to cycling health benefits and transport efficiency benefits arising from bicycle commuting. This analysis will inform potential cost saving associated with cycling safety investments such as the recommended infrastructure improvements. The findings of the analysis could be used in the implementation of the *Victorian Cycling Strategy 2018-2028 – Increased cycling for transport.* It is noted that there is some guidance provided in the Australian Transport Assessment and Planning Guidelines for active travel. However, further research could quantify the economic costs of different levels of injury.
9.	**10.**
It is recommended that research is undertaken to evaluate the impact of cyclist education programs in childhood on adult cycling outcomes including cycling participation, safety perceptions, and injury incidence.	Harmonisation of the police-reported, hospital admission and Transport Accident Commission injury claims data currently underway should be extended to include Ambulance data to complete the serious injury and fatality crash understanding in Victoria.

Injury Surveillance and Coding

11.	12.
Additional data collection through VEMD free-text fields may lead to improved identification of cyclist injury causes and hazardous circumstances that lead to cyclist falls and crashes. This would include improvements to the recording of infrastructure type, injury/crash location, speed limits and traffic conditions. This recommendation can be achieved through the current VEMD injury surveillance data quality project.	Continued monitoring of trends in adult bicycle injury hospital admissions once the influence of the changes made to the Victorian hospital admission policy are settled, concurrently accounting for cycling exposure trends, will provide a more informative overview of bicycle injury and relative safety trends.

REFERENCES

ABS. (2008). Information Paper: Cause of Death Certification, Australia *Cat. no. 1205.0.55.001.* Canberra (AUST).

Airaksinen, N. K., Nurmi-Lüthje, I. S., Kataja, J. M., Kröger, H. P. J., & Lüthje, P. M. J. (2018). Cycling injuries and alcohol. *Injury, 49*(5), 945-952. doi: https://doi.org/10.1016/j.injury.2018.03.002

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

Australian Institute of Health and Welfare. (2015). National Data Dictionary: Version 16.2. Canberra.

Austroads. (2019). Australian Cycling Participation 2019. Sydney: Austroads.

Bauman, A., Rissel, C., Garrard, J., Ker, I., Speidel, R., & Fishman, E. (2008). *Cycling: Getting Australia Moving: Barriers, Facilitators and Interventions to Get More Australian Physically Active Through Cycling: Executive Summary:* Department of Health and Ageing Melbourne, Australia.

Bauman, A., Titze, S., Rissel, C., & Oja, P. (2011). Changing gears: bicycling as the panacea for physical inactivity? : British Association of Sport and Excercise Medicine.

Bauman, A. E., Blazek, K., Reece, L., & Bellew, W. (2018). The emergence and characteristics of the Australian Mamil. *Medical Journal of Australia, 209*(11), 490-494. doi: 10.5694/mja18.00841

Beck, B., Chong, D., Olivier, J., Perkins, M., Tsay, A., Rushford, A., … Johnson, M. (2019a). How much space do drivers provide when passing cyclists? Understanding the impact of motor vehicle and infrastructure characteristics on passing distance. *Accident Analysis & Prevention,* 128, 253-260.

Beck, B., Stevenson, M., Newstead, S., Cameron, P., Judson, R., Edwards, E. R., … Gabbe, B. (2016). Bicycling crash characteristics: an in-depth crash investigation study. *Accident Analysis & Prevention, 96*, 219-227.

Beck, B., Stevenson, M. R., Cameron, P., Oxley, J., Newstead, S., Olivier, J., . . . Gabbe, B. J. (2019b). Crash characteristics of on-road single-bicycle crashes: an under-recognised problem. *Injury Prevention,* 25(5), 448-452.

Biegler, P., Newstead, S., Johnson, M., Taylor, J., Mitra, B., & Bullen, S. (2012). MACCS Monash Alfred cyclist crash study.

Boufous, S., de Rome, L., Senserrick, T., & Ivers, R. (2012). Risk factors for severe injury in cyclists involved in traffic crashes in Victoria, Australia. *Accident Analysis & Prevention, 49,* 404-409. doi: https://doi.org/10.1016/j.aap.2012.03.011

Boufous, S., de Rome, L., Senserrick, T., & Ivers, R. Q. (2013). Single- versus multi-vehicle bicycle road crashes in Victoria, Australia. Injury Prevention. doi: 10.1136/injuryprev-2012-040630

Chong, S., Poulos, R., Olivier, J., Watson, W. L., & Grzebieta, R. (2010). Relative injury severity among vulnerable non-motorised road users: comparative analysis of injury arising from bicycle–motor vehicle and bicycle–pedestrian collisions. *Accident Analysis & Prevention, 42*(1), 290-296.

Cobey, K. D., Laan, F., Stulp, G., Buunk, A. P., & Pollet, T. V. (2013). Sex Differences in Risk Taking Behavior among Dutch Cyclists. *Evolutionary Psychology, 11*(2). doi: 10.1177/147470491301100206

Currie, G., & Delbosc, A. (2011). Exploring the trip chaining behaviour of public transport users in Melbourne. *Transport Policy,* 18(1), 204-210.

Daley, M., Rissel, C., & Lloyd, B. (2007). All Dressed Up and Nowhere to Go?: A Qualitative Research Study of the Barriers and Enablers to Cycling in Inner Sydney. *Road & Transport Research: A Journal of Australian and New Zealand Research and Practice, 16*(4), 42.

De Hartog, J. J., Boogaard, H., Nijland, H., & Hoek, G. (2010). Do the health benefits of cycling outweigh the risks? *Environmental health perspectives*, 1109-1116.

Department of Health and Human Services. (2019). Victorian public health and wellbeing plan 2019-2023.

Dickinson, J. E., Lumsdon, L. M., & Robbins, D. (2011). Slow travel: Issues for tourism and climate change. *Journal of Sustainable Tourism,* 19(3), 281-300.

Fishman, E., Washington, S., & Haworth, N. L. (2012). Understanding the fear of bicycle riding in Australia. *Journal of the Australasian College of Road Safety, 23*(3), 19-27.

Fraser, M. L. (2019). *Group Riding in Western Australia: An Examination of Crashes, Outcomes and Behaviour.* Curtin University.

Garrard. (2009). Active transport: Adults - An Overview of recent evidence. Melbourne: VicHealth.

Garrard, J., Crawford, S., & Hakman, N. (2006). Revolutions for women: increasing womens participation in cycling for recreation and transport.

Garrard, J., Greaves, S., & Ellison, A. (2010). Cycling injuries in Australia: Road safety's blind spot? *Journal of the Australasian College of Road Safety, 21*(3), 37.

Garrard, J., Rose, G., & Lo, S. K. (2008). Promoting transportation cycling for women: the role of bicycle infrastructure. *Prev Med, 46*(1), 55-59. doi: 10.1016/j.ypmed.2007.07.010

Handy, S., Van Wee, B., & Kroesen, M. (2014). Promoting cycling for transport: research needs and challenges. *Transport Reviews,* 34(1), 4-24.

Haworth, N. L., & Schramm, A. J. (2011). Adults cycling on the footpath: what do the data show?

Hayman, J., & Berecki-Gisolf, J. (2019). E-bulletin Edition 19. Unintentional (accidental) hospital-treated injury Victoria, 2017/18. Melbourne, Victoria: Victorian Injury Surveillance Unit, Monash University.

Heesch, K. C., Sahlqvist, S., & Garrard, J. (2012a). Gender differences in recreational and transport cycling: a cross-sectional mixed-methods comparison of cycling patterns, motivators, and constraints. *Int J Behav Nutr Phys Act, 9,* 106. doi: 10.1186/1479-5868-9-106

Heesch, K. C., Sahlqvist, S., & Garrard, J. (2012b). Gender differences in recreational and transport cycling: a cross-sectional mixed-methods comparison of cycling patterns, motivators, and constraints. *International Journal of Behavioral Nutrition and Physical Activity, 9*(1), 106.

Hillman, M., & Morgan, D. R. (1992). *Cycling: towards health and safety.* British Medical Association: Oxford University Press.

Johnson, M., Newstead, S., Oxley, J., & Charlton, J. (2013). Cyclists and open vehicle doors: Crash characteristics and risk factors. *Safety Science, 59*(Supplement C), 135-140. doi: https://doi.org/10.1016/j.ssci.2013.04.010

Johnson, M., Oxley, J., & Cameron, M. H. (2009). *Cyclist bunch riding: A review of the literature:* Monash University Accident Research Centre Victoria.

Lawrence, B. M., Stevenson, M. R., Oxley, J. A., & Logan, D. B. (2015). Geospatial Analysis of Cyclist Injury Trends: An Investigation in Melbourne, Australia. *Traffic Injury Prevention, 16*(5), 513-518. doi: 10.1080/15389588.2014.973947

Macpherson, A., & Spinks, A. (2008). Cochrane review: Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. Evidence-Based Child Health: A Cochrane Review Journal, 3(1), 16-32. doi: 10.1002/ebch.211

Martens, K. (2007). Promoting bike-and-ride: The Dutch experience. *Transportation Research Part A: Policy and Practice, 41*(4), 326-338. doi: http://dx.doi.org/10.1016/j.tra.2006.09.010

Mindell, J. S., Leslie, D., & Wardlaw, M. (2012). Exposure-based,'like-for-like'assessment of road safety by travel mode using routine health data. PloS one, 7(12), e50606.

Morrison, C. N., Thompson, J., Kondo, M. C., & Beck, B. (2019). On-road bicycle lane types, roadway characteristics, and risks for bicycle crashes. *Accident Analysis & Prevention,* 123, 123-131.

O'Hern, S., & Oxley, J. (2015). Understanding travel patterns to support safe active transport for older adults. *Journal of Transport & Health, 2*(1), 79-85. doi: http://dx.doi.org/10.1016/j.jth.2014.09.016

O'Hern, S., & Oxley, J. (2018). Fatal cyclist crashes in Australia. *Traffic Injury Prevention,* 1-19. doi: 10.1080/15389588.2018.1497166

O'Hern, S., & Oxley, J. (2019). Pedestrian injuries due to collisions with cyclists Melbourne, Australia. *Accident Analysis & Prevention, 122,* 295-300.

Pucher, J., & Buehler, R. (2008). Making cycling irresistible: lessons from the Netherlands, Denmark and Germany. *Transport Reviews, 28*(4), 495-528.

Pucher, J., Garrard, J., & Greaves, S. (2010). Cycling down under: a comparative analysis of bicycling trends and policies in Sydney and Melbourne. *J Transp Geogr, 18.*

Scheiner, J., & Holz-Rau, C. (2017). Women's complex daily lives: a gendered look at trip chaining and activity pattern entropy in Germany. *Transportation, 44*(1), 117-138.

Shaw, L., Poulos, R., Rissel, C., & Hatfield, J. (2012). *Exploring the application of the Safe System Approach to cycling.* Paper presented at the Australasian Road Safety Research Policing Education Conference, 2012, Wellington, New Zealand.

State Government of Victoria. (2016). Towards Zero, Victoria's Road Safety Strategy & Action Plan. Victoria.

Stephens, A. N., O'Hern, S., Trawley, S., Young, K. L., & Koppel, S. (2019). Self-reported aggression amongst active cyclists. *Accident Analysis & Prevention, 128,* 46-52. doi: https://doi.org/10.1016/j.aap.2019.04.004

Stephenson, S., Henley, G., Harrison, J. E., & Langley, J. (2003). Diagnosis-based Injury Severity Scaling *Injury Research and Statistics Series Number 20.* https://www.aihw.gov.au/reports/injury/diagnosis-based-injury-severity-scaling/contents/table-of-contents: AIHW.

Stevenson, M., Johnson, M., Oxley, J., Meuleners, L., Gabbe, B., & Rose, G. (2015). Safer cycling in the urban road environment: study approach and protocols guiding an Australian study. *Inj Prev, 21*(1), e3. doi: 10.1136/injuryprev-2014-041287

Stevenson, M., Thompson, J., de Sá, T. H., Ewing, R., Mohan, D., McClure, R., . . . Sun, X. (2016). Land use, transport, and population health: estimating the health benefits of compact cities. The Lancet, 388(10062), 2925-2935.

Transport for Victoria. (2017). *Victorian Cycling Strategy 2018-28.* 1 Spring Street, Melbourne, Victoria 3000.

Useche, S. A., Alonso, F., Montoro, L., & Esteban, C. (2018). Distraction of cyclists: how does it influence their risky behaviors and traffic crashes? *PeerJ, 6,* e5616.

WHO. (2007). *Global age-friendly cities: A guide:* World Health Organization.

Winters, M., Davidson, G., Kao, D., & Teschke, K. (2011). Motivators and deterrents of bicycling: comparing influences on decisions to ride. *Transportation, 38*(1), 153-168. doi: 10.1007/s11116-010-9284-y

Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., . . . Cohen, A. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. *The Lancet, 374*(9705), 1930-1943.

APPENDIX:

APPENDIX A: DATA SOURCES AND CASE SELECTION

The scope of this Hazard is limited to unintentional on-road cyclist injury in Victoria to persons aged 15 years and over.

CAUSE OF DEATH DATA

Data were extracted from the VISU-held Cause of Death (COD) dataset supplied by the Australian Coordinating Registry (ACR) and based on the Australian Bureau of Statistics (ABS) cause of death data. Adult on-road cyclist deaths were selected using ICD-10 underlying cause of death (UCoD) codes in the range of V10-V19 (pedal cyclist injured in transport accident) restricted to external cause sub-codes 4-6 or 9 (pedal cycle driver, passenger or cyclist of unspecified type involved in "traffic" or "on-road"). Case selection was limited to deaths registered between the 11-year period ranging from January 2007 to December 2017.

To improve the quality of ICD coding, the ABS introduced a revisions process for all coroner certified deaths registered after 1 January 2006. The process means data are preliminary when published for the first time, revised when published the following year and final when published two years after initial publication. For more detailed information regarding the ABS causes of death coding and revisions processes, readers are directed to the ABS website and in particular:

http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/3303.0Technical+Note12012

HOSPITAL ADMISSIONS

Hospital admissions data were extracted from the Victorian Admitted Episodes Dataset (VAED), which records all admissions to public and private hospitals in the state of Victoria. The VAED includes demographic, clinical and administrative details for every admitted episode of care. The coding in the VAED conforms to the definitions in the National Health Data Dictionary (NHDD) (Australian Institute of Health and Welfare, 2015).

The clinical details include forty diagnosis codes that include injury and external cause information coded according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM). Hospital admissions between 01 July 2008 and 30 June 2018 were selected.

Hospital admissions between 01 July 2008 and 30 June 2018 were selected and were limited to community injuries (i.e. first diagnosis code in the ICD-10-AM code range of S00-T75 or T79). Selection was also limited to cases where 'human intent' was coded as unintentional (code='1'). Transfers within and between hospitals were excluded to avoid over-counting the incidence, but were included when providing estimates of direct hospital costs and number of hospital bed-days as their inclusion provides a more accurate estimate of the burden of injury.

Table A1 shows the ICD10-AM external cause codes used for selection of hospital admissions from the VAED. Records were retained if the ICD10-AM external cause was in the range 'V10' to 'V1999' for 'pedal cyclist injured in transport accident'. Cases were further selected as 'on road' if the 4th character of the ICD10-AM code indicated that the collision occurred in 'traffic' OR the place variable indicated it took place on a 'road, street or highway'.

Table A1

ICD10-AM Codes for Selection of Hospital Admissions from the VAED

ICD10-AM cause codes include:	AND collision was 'on road'
'V10' to 'V109' collision with pedestrian or animal	4th character of ICD10-AM code equals 4, 5 or 9, indicating a traffic collision OR place variable indicates road, street or highway
'V110' to 'V119' collision with other pedal cycle	As above
'V120' to 'V129' collision with 2 or 3 wheeled vehicle	As above
'V130' to 'V139' collision with car, pick-up truck or van	As above
'V140' to 'V149' collision with heavy transport vehicle or bus	As above
'V150' to 'V159' collision with railway train or vehicle	As above
'V160' to 'V169' collision with other non-motor vehicle - animal drawn, streetcar	As above
'V170' to 'V179' collision with fixed or stationary object	As above
'V180' to 'V189' non-collision transport accident - fall or thrown from pedal cycle, overturning	As above
'V190' to 'V199' other and unspecified transport accidents	4th character of ICD10-AM code equals 4, 5, 6 or 9, indicating a traffic accident OR place variable indicates road, street or highway

EMERGENCY DEPARTMENT PRESENTATIONS

Emergency Department presentations data were extracted from the Victorian Emergency Minimum Dataset (VEMD), which records all presentations to Victorian public hospitals with 24-hour emergency departments (currently 38 hospitals). The VEMD records cases that are treated and discharged from the ED, and cases that are assessed in the ED and admitted to a ward for treatment.

An 'emergency department (ED) presentation for injury' is an injury or poisoning that results in a person presenting to a hospital emergency department for treatment who is triaged (assessed for urgency), including those patients who leave before treatment commences.

ED presentations between 01 July 2008 and 30 June 2018 were selected. They were limited to community injuries (i.e., with the first diagnosis code in the ICD-10-AM code range of S00-T75 or T79) and incidence (i.e., return and pre-arranged visits excluded to avoid over counting). Selection was also limited to cases where 'human intent' was coded as unintentional (code="1") or undetermined intent (i.e., intent cannot be determined (code="9"), other specified intent (code="10") or intent not specified (code="11")).

Case identification of bicycle-related injury in the VEMD was based on text searches as well as the 'National Minimum Data Standards (NMDS)' for injury surveillance codes.

VEMD Case Selection Based on Text Searches

These were selected if the 'Description of injury event' variable in the VEMD, which is a short narrative of the incident, mentioned terms relevant to bicycles, such as cycle, bike, bicycle, pba (pushbike accident), pushbike, mountain bike, and their variations and derivatives. Cases selected with this method were checked manually for relevance.

VEMD case selection based on NMDS codes

These were selected if the 'injury cause' was coded as a "pedal cyclist - rider or passenger" (code="5"). Any cases with injury-cause="5" but clearly indicating a motorbike, car etc. in the text variable were excluded.

Finally, case selection was limited to those considered to be 'on-road' incidents. That is, by selecting any record with the 'place where injury occurred' field indicating 'road, street or highway (code="R")'. Cases were also considered as on-road if the place was 'other specified place (code="O")' or 'unspecified place (code="U")', both with the 'description of event' field containing terms such as 'road', 'car', 'bus', 'van', 'ute', 'truck', 'trailer', 'kerb', 'tram', 'gutter', 'street', 'court', 'highway' and their variations and derivatives.

AMBULANCE ATTENDANCE DATA

Ambulance attendance cases were provided by Ambulance Victoria (AV). AV data is based on data collected by paramedics at the point of care in the field, recorded on an electronic tablet utilising Victorian Ambulance Clinical Information System (VACIS) and synchronised to AV's data warehouse. VACIS is a patient care record computer application specifically designed for Australian ambulance services. Although originating in Victoria, it is used in every ambulance service in Australia's eastern states, covering 80% of the Australian population.

However, prehospital injuries are not ICD-10-AM coded due to the lack of diagnostic imaging resources available in the prehospital setting. This dataset is largely text based with limited coding compared to established VISU datasets. It should be noted that AV data is of a high quality and the lack of coding is a product of the environment it is recorded in. What this dataset lacks in coding is more than compensated in the level of detail provided in case description variables.

Ambulance Victoria identified records for this edition of Hazard by selecting "Case Nature" variable codes representing "Trauma: Bicycle" and "Bicycle Collision" incidents. Ambulance Victoria flagged duplicates or multi-transfers for the same patient for the same incident using their name and postcode of residence and assigned a non-identifying cluster id to these records. This allowed VISU to decide which records to include based on dates of ambulance attendance. Potential duplicate records accounted for 10% (n=1889) of the dataset over the 10-year period and 69% of these records were for valid separate bicycle-related incidents. True duplicates were discarded from the dataset (n=591).

The "Scene Location Type" variable does not represent location of injury to the same degree as it does in other VISU datasets. In Ambulance Victoria data, the location variable describes the actual location attended by paramedics. This might not always be the same place where the injury event has occurred. An example of this would be a cyclist being injured while riding on-road but managing to ride home and call an ambulance later. In this instance, location type would be coded as "home" rather than "street/public road" which is where the initial injury incident occurred. Therefore, there are instances where the attendance location matches the incident location, so VISU used this variable in combination with a long list of included and excluded terms within the case narrative text to eliminate non-road or off-road related records.

Excluded terms associated with off-road or non-traffic related cycling (along with possible misspellings) included:

- rail trail, bike path, bke path, bike track, forrest track, dirt track, bush track, gravel track, gravel path, off road, BMX track, Mystic mountain, mystic mountain, Mystic Mountain, skate park, skatepark, skate bowl, stunt, trick, stunt, trick, dirt bike, mountain biking, mountain bike riding, cross country cycling race, bridge, velodrome, valadrome, race track, performing, jump, jumped, racing track;

Included terms associated with on-road or traffic related cycling (along with possible misspellings) included:

- car, cars, motor vehicle, motor vehicles, vehicle, vehicles, ute, 4WD, 4 wheel drive, sedan, , hatchback, SUV, truck, van, bus, train, caravan, car door, vehicle door, Vehicle door, tram track, tram tracks, tram line, tram, tram, parked car, parking car, stationary car, stationary cars, taxi, trailer, trailor, between car, between cars, BTW car, btw car, sideswiped, collided with, gutter, kerb, curb, swooped, bollard, car pulled out, car pulling out, car turned in front of, triathlon, triathalon, caught in drain, caught in steel drain, road bicycle, road bike, road cycling, cycling tour, road race, three peaks challenge, 3 peaks challenge, pot hole, pothole, round-a-bout, roundabout, round about, round-a-about, round-about, street, streets, road, roads, Rd, highway, hwy, freeway, intersection, sidestreet, side street, speed hump speedhump, roadway, traffic, group of cyclists, group cyclists, group of other cyclists, fellow riders, riding with friends, pack of friends, bunch, pelleton, pellaton, peloton, pack riding, large group, power pole, pedestrian, bike lane, bicycle lane, cycling lane;

APPENDIX B: STATISTICAL ANALYSIS

Rates for ambulance attendances, ED presentations, hospital admissions and deaths per 100,000 population, by age, sex and year were calculated using population data sourced from the Australian Bureau of Statistics (ABS), Estimated Residential Population. Population data was provided by age, sex, and year.

Trend analysis: changes in the rates of ambulance attendances, ED presentations and hospital admissions per population were modelled using Poisson models, as trends in the annual number of events, with the log of the Victorian population as offset. All models contained financial year (time indicator) and were adjusted for age group and sex, where possible (i.e. unless the analysis was limited to a single age group or sex). The percentage change per year was calculated as: $[e^{\alpha} – 1] \times 100$, where α is the model-estimated rate of increase or decrease. The analyses were conducted using the PROC GENMOD procedure in SAS V9.4.

THE RESEARCH PRESENTED IN THIS ISSUE OF HAZARD HAS IDENTIFIED THAT ON-ROAD CYCLISTS ARE EXPERIENCING INCREASED RATES OF TRAUMA IN VICTORIA. THE FINDINGS HIGHLIGHT THAT CYCLIST TRAUMA IS A GROWING PUBLIC HEALTH ISSUE THAT IS RESULTING IN SIGNIFICANT ECONOMIC COSTS TO THE COMMUNITY.

APPENDIX C OVERNIGHT STAY HOSPITAL ADMISSION TRENDS

Ten-Year Trends in Cyclist Injury, in Terms of Overnight (Non-Same Day) Hospital Admissions (2008/9 to 2017/18) in Victoria

Overnight Hospital Admissions, 2008/9 to 2017/18			
	Freq, Total (n)	Annual Rate† (per 100,000 pop)	Change in Rate, Annually (%)‡
Overall	**11447**	**24.4**	+2.9 [+1.9, +3.8]
Demographics			
Males	8917	39.0	+2.8 [+1.9, +3.7]
15-24 years	1251	31.3	0.0 [-1.9, +1.9]
25-34 years	1648	37.9	0.0 [-2.0, +1.9]
35-44 years	1984	49.2	+2.2 [+0.1, +4.3]
45-54 years	1829	48.6	+2.9 [+1.0, +4.8]
55-64 years	1299	40.7	+7.6 [+5.2, +10.2]
65-74 years	655	28.5	+7.1 [+3.7, +10.6]
75+ years	251	15.9	+6.6 [+2.2, +11.1]
Females	2530	10.4	+3.0 [+1.5, +4.5]
15-24 years	324	8.2	+0.7 [-3.5, +5.0]
25-34 years	631	14.3	+1.5 [-2.5, +5.6]
35-44 years	432	10.5	+1.4 [-3.0, +6.0]
45-54 years	495	12.6	+3.3 [+0.7, +5.9]
55-64 years	412	12.5	+5.5 [+1.8, +9.4]
65-74 years	198	8.1	+9.7 [+4.9, +14.7]
75+ years	38	1.9	N/A

†Age-standardised to the 2011 reference population. ‡Poisson modelling, adjusted for age group in 10-year bands and sex.

APPENDIX D ‘URGENT’ ED PRESENTATION TRENDS

Ten-Year Trends in Cyclist Injury, in Terms of ED Presentations Triaged as Urgent, 2008/9 to 2017/18, Victoria

ED Presentations Triaged as Urgent*, 2008/9 to 2017/18			
	Freq, total (n)	Annual Rate† (per 100,000 pop)	Change in Rate, Annually (%)‡
Overall	16394	35.3	+1.4 [+0.6, +2.2]
Demographics			
Males	12687	56.0	+1.4 [+0.6, +2.2]
15-24 years	2445	61.2	-0.2 [-1.4, +1.0]
25-34 years	2778	63.9	-1.8 [-3.1, -0.4]
35-44 years	2846	70.6	+1.9 [-0.1, +3.8]
45-54 years	2369	62.9	+3.4 [+1.5, +5.4]
55-64 years	1412	44.5	+4.5 [+2.2, +6.9]
65-74 years	628	27.4	+6.0 [+3.1, +8.9]
75+ years	209	13.5	+2.0 [-2.6, +6.8]
Females	3707	15.6	+1.4 [+0.2, +2.6]
15-24 years	638	16.2	+0.4 [-2.3, +3.2]
25-34 years	1235	28.1	-0.7 [-3.1, +1.8]
35-44 years	707	17.2	+1.3 [-1.2, +3.8]
45-54 years	586	14.9	+4.3 [+1.6, +7.2]
55-64 years	366	11.1	+5.9 [+2.1, +9.9]
65-74 years	140	5.9	+1.1 [-4.9, +7.5]
75+ years	35	1.7	N/A

*Cases were only selected if the triage category was: ‘resuscitation’; ‘emergency’, or ‘urgent’. †Age-standardised to the 2011 reference population. ‡Poisson modelling, adjusted for age group in 10-year bands and sex.

HAZARD EDITION INDEX

Subject	Edition
Asphyxia	60
Assaults	55,73,79,83
Babywalkers, update	16,20,25,34
Baseball	30
Boating-Related Recreational Injury	56
Bunkbeds	11,75
Button Batteries	75
Bicycles	
Bicycle Related	6,31,34,44,65,87
Cyclist Head Injury Study	2,7,8,10
Adult On-Road Cyclist Injury	87
Burns	
Scalds, Burns Prevention	3,12,25
Unintentional Burns and Scalds in Vulnerable Populations	57
Child Care Settings	16,76
Client Survey Results	28
Co-Morbidity Analysis	80
Cutting and Piercing (Unintentional)	52
Data Base Use, Interpretation & Example of Form	2
Deaths From Injury (Victoria)	11,38,76, 80,83,85
Dishwasher Machine Detergents – Update	18
Diy Maintenance Injuries	41
Dog Bites, Dog Related Injuries	3,12,25,26, 34,69
Domestic Architectural Glass	7,22,25
Domestic Violence	21,30,79,83
Drowning/Near Drowning, Including Updates	2,5,7,30, 34,55
Elastic Luggage Straps	43
Escalator	24
Exercise Bicycles, Update	5,9
Falls - Child, Older Persons, Home, Bunk Beds	44,45,48,59,65, 75,77,78,80
Farm, Tractors	24,30,33,47,68
Finger Jam (Hand Entrapment)	10,14,16,25,59
Fireworks	47
Geographic Regions of Injury	46,85
Health Service Areas	76
Home	14,32,59,65, 76,80
Horse Related	7,23
Infants - Injuries in the First Year of Life	8
Injury Surveillance Developments, inc. ICD-10 Coding	30,43
Intentional	13,83

Subject	Edition
Latrobe Valley	
First 3 Months, Injury Surveillance & Prevention	9
Ladders	63
Lawn Mowers	22
Marine Animals	56
Martial Arts	11
Mobility Scooters	62
Motor Vehicle Related, Non-Traffic, Vehicle Jack Injuries	20,63
Motorcycles	64,65,81
Needle Stick Injuries	11,17,25
Nursery Furniture	37,44
Older People	19,67,80,84
Off-Street Parking Areas	20
Pedestrians	71,72
Playground Equipment	3,10,14,16,25, 29,44,61,65,77
Poisons	
Domestic Chemical and Plant Poisoning	28
Drug Safety a0nd Poisons Control	4
Dishwasher Detergent, Update	10,6
Early Childhood, Child Resistant Closures	2,27,47
Adult Overview	39
Opioids (Unintentional and Intentional)	86
Power Saws, Chainsaws	22,28
Regional Injury Profiles	85
Residential Institutions	76,84
Road injury	36,65,76
Roller Blades, Skateboards, Scooters	2,5,25,31,44,78
School	10,76
Settings for Injury	76
Shopping Trolleys	22,25,42
Smoking-Related	21,25,29,44
Socio-Economic Status and Injury	49,70
Sports - Child Sports, Adult Sports, Surf Sports, Snow Sports	8,9,44,15,51, 56,66,74,76
Suicide - Motor Vehicle Exhaust Gas	11,20,25,41
Trade and Service Areas	76
Trail Bikes	31
Trampolines	13,42,61,75
Vapouriser Units	43
Venomous Bites and Stings	35
VISS: How it Works, Progress, A Decade of Victorian Injury Surveillance	1,26,40
VISAR: Celebration of Visar Achievements, VISAR Name Change to VISU	50,61
Work-Related	17,18,58,76,82

VAED includes all Victorian public and private hospitals

VEMD Participating hospitals

From October 1995

Austin & Repatriation Medical Centre
Ballarat Base Hospital
The Bendigo Hospital Campus
Box Hill Hospital
Echuca Base Hospital
The Geelong Hospital
Goulburn Valley Base Hospital
Maroondah Hospital
Mildura Base Hospital
The Northern Hospital
Royal Children's Hospital
St Vincent's Public Hospital
Wangaratta Base Hospital
Warrnambool & District Base Hospital
Western Hospital - Footscray
Western Hospital - Sunshine Williamstown Hospital
Wimmera Base Hospital

From November 1995

Dandenong Hospital

From December 1995

Royal Victorian Eye & Ear Hospital
Frankston Hospital

From January 1996

Latrobe Regional Hospital

From July 1996

Alfred Hospital
Monash Medical Centre

From September 1996

Angliss Hospital

From January 1997

Royal Melbourne Hospital

From January 1999

Werribee Mercy Hospital

From December 2000

Rosebud Hospital

From January 2004

Bairnsdale Hospital
Central Gippsland Health Service (Sale)
Hamilton Base Hospital
Royal Women's Hospital
Sandringham & District Hospital
Swan Hill Hospital
West Gippsland Hospital (Warragul)
Wodonga Regional Health Group

From January 2005

Mercy Hospital for Women

From April 2005

Casey Hospital

From July 2011

Bass Coast Regional Health

How to Access VISU Data

VISU collects and analyses information on injury problems to underpin the development of prevention strategies and their implementation. VISU analyses are publicly available for teaching, research and prevention purposes. Requests for information can be lodged via the data request form on the VISU website or by contacting the VISU office by phone.

Injury Atlas of Victoria

The *Injury Atlas of Victoria* is a new web-based tool that allows the exploration of hospital-treated unintentional injury in Victoria and further enhances the services that VISU provides. It was developed by VISU at Monash University and presents de-identified hospital-treated unintentional injury data supplied by the Department of Health and Human Services Victoria. This can be used by government departments and agencies of all levels, health and injury prevention organisations, media, business and industry, education institutions, research groups and the community.

The *Injury Atlas of Victoria* can be accessed at this address: **vicinjuryatlas.org.au/**

VISU Staff

Director: Associate Professor Janneke Berecki-Gisolf
Research Fellow: Dr Angela Clapperton
Senior Research Officer: Voula Z. Stathakis
Data Analyst: Tharanga Fernando
Data Analyst: Dr Jane Hayman
Statistical Advisor: Angelo D’Elia
Administration Officer: Samantha Bailey

Acknowledgements:

VISU would like to acknowledge the following parties for their contributions to this edition of Hazard: Ambulance Victoria, Professor Karen Smith and Dr Shelley Cox, the Department of Health and Human Services (DHHS), and the Cause of Death Unit Record File (COD-URF) data custodians.

MONASH University

ACCIDENT RESEARCH CENTRE

Contact VISU at:
MUARC - Monash University Accident Research Centre
Building 70, 21 Alliance Lane
Monash University
Clayton Campus
Victoria, 3800
Phone: (03) 9905 1805
Email: **visu.enquire@monash.edu**

All issues of Hazard and other information and publications of the Monash University Accident Research Centre can be found on our internet home page:

www.monash.edu/muarc/visu

VICTORIA State Government | Health and Human Services

VISU is a unit within the Monash University Accident Research Centre (MUARC). VISU is supported by the Victorian Government.

Hazard was produced by the Victorian Injury Surveillance Unit (VISU)

DESIGNED AND PRODUCED BY MPS MONASH: 356809 APRIL 2020. CRICOS PROVIDER: MONASH UNIVERSITY 00008C.