

## Circumstances of on-road single-vehicle cyclist crashes in the Australian Capital Territory

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### ABSTRACT

Despite the large number of single- vehicle bicycle crashes, very little is known about their risk factors. The lack of research in this area is mainly due to under reporting of these crashes in police crash data and lack of information about the circumstances leading to their occurrence in other administrative data (i.e. hospital data).

The study examines the circumstances of single-vehicle cyclist crashes that occur on public roads.

A survey of adult cyclists who were injured as a result of a crash and presented to emergency departments in the Australian Capital Territory over a period of 6 months, November 2009 to May 2010. Participants injured in on-road single-vehicle crashes are the focus of this paper.

Overall, 105 cyclists reported being involved in on-road single-vehicle crashes which corresponds to 32% of all study participants and just over half of those involved in all single-vehicle crashes, including those that occurred off-road. Just over 66% of cyclists involved in on-road single-vehicle crashes first learned to ride when they were aged 5 to 9 years and just under 90% were regular cyclists riding an average of over 30Km per week. Almost three quarters reported losing control of the bicycle and about a quarter reported surface characteristics as contributing factors to the crash. Behavioural factors such as distraction (21%), speeding (16.2%) and alcohol (5.7%) as well as bike failure (19.6%) also contributed to the crash according to study participants.

The findings point to the importance of maintenance of roads frequently used by cyclists and the need for more research into the role of riding and bicycle handling skills training as well as cyclists education in preventing on-road single-vehicle crashes.

**Keywords:** cyclist, injury, crash, single.

## **1 INTRODUCTION**

Cyclists are recognised as one of the most vulnerable road users as they negotiate their way in a road environment seldom designed with their safety in mind. Previous research has shown that cyclists have a 7.5 times the risk of injury per kilometers travelled and up to 10 times the risk of death compared to car occupants [1, 2]. These statistics coupled with an increase in the popularity of cycling, particularly in high income countries, have resulted in a significant amount of research that examined the risk factors of crashes involving collisions between cyclists and motor vehicles [3-5]. Such research has informed significant investment in infrastructure to regulate and in some cases to limit interactions between cyclists and motor vehicles [6].

However, most cycle related injuries do not result from interactions with motor vehicles and other road users. Studies based on health care services data found that single-vehicle bicycle crashes make up more than 60% of injurious cyclist crashes and that this proportion is on the rise [7-10]. Despite the large number of, and substantial medical costs associated with single-vehicle bicycle crashes [11], very little is known about their risk factors and the circumstances leading to their occurrence. The lack of research in this area is mainly due to under reporting of single-vehicle cyclist crashes in police crash data. Health care data (i.e. emergency, hospital and trauma registry data) which better capture the prevalence of single-vehicle crashes lack in depth information on the circumstances of the crash. In addition, research that has examined the issue of single-vehicle crashes using health data did not differentiate between bicycle crashes that occur in off-road locations and those that occur on the road- two types of crashes that are likely to have different risk factors.

This study examines the circumstances of single-vehicle crashes that occur on public roads based on a survey of injured cyclists presenting to Emergency Departments in the Australian Capital Territory.

## **2 METHODS**

Data was collected as part of a cross sectional survey of bicycle crashes conducted between November 2009 and May 2010 in the Australian Capital Territory, an area consisting of an urban centre surrounded by a rural region with a population of 345,900 [12]. Eligible participants were residents of the area, aged 17-70 years, who had been injured in a bicycle crash and presented to either of the two hospital Emergency Departments servicing the area. These are a major regional public hospital and a small emergency department at a private hospital. Cyclists were not approached to participate if they had severe head (AIS3+) or spinal injuries (AIS4+) as rated on the Abbreviated Injury Scale (AIS); had post traumatic amnesia for 24 hours or more; rated less than thirteen on the Glasgow Coma Scale or were considered to be medically unfit or otherwise unable to provide informed consent.

Potential participants were identified from Emergency Department presentation records and sent letters and then telephoned to request their participation in the study. Those who agreed to participate were interviewed within two to three weeks of the crash either in-person at hospital or at home by telephone. The structured survey questionnaire used in the study contained questions related to the crash circumstances, specific location, type of bicycle, and the injury outcomes, in addition to background information about their cycling experience. The questionnaire mainly contained close ended questions, including those on the circum-

stances of and contributing factors to single-vehicle cyclist crashes. An open question on the circumstances of the crash was also included.

Data analysis focused on the characteristics and circumstances of on-road single-vehicle bicycle crashes. On-road crashes, also referred to as traffic crashes, are those that are potentially reportable to police and include crashes that occur on public roads, cycle lanes, shared paths, driveways and pedestrian paths/areas. Single-vehicle crashes are defined as those where the cyclist was injured in a non-collision crash or in a collision with fixed or stationary objects. The analyses were conducted in SAS 9 [13].

### 3 RESULTS

Overall 105 cyclists reported being involved in on-road single-vehicle crashes which corresponds to 32% of cyclists injured in all crashes and just over half of those involved in single-vehicle crashes, including off-road crashes. Two thirds of cyclists involved in on-road single-vehicle crashes were males with a similar proportion aged between 25 and 54 years. Just over 66% of cyclists involved in on-road single vehicle crashes first learned to ride when they were aged 5 to 9 years and just under 90% were regular cyclists riding an average of over 30 km per week with half riding over 100 km per week. Less than one in five cyclists involved in on-road single-vehicle crashes (19%) undertook cycle training. Nearly half of on-road single-vehicle crashes were associated with commuting (48.6%) with another 30% occurring as a result of involvement in recreational riding. The majority of cyclists injured in on-road single-vehicle crashes were wearing a helmet (82.9%), 39% presented to a hospital immediately after the crash and 8.6% were admitted as result of the injury sustained. Only 2.9% of cyclists reported the crash to the police (Table 1).

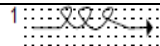
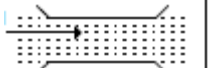

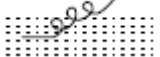
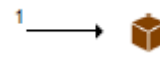
**Table 1.** Individual characteristics and outcomes of on-road single-vehicle cyclist crashes

	<i>N</i>	%
<b>Gender</b>		
male	70	66.7
female	35	33.3
<b>Age</b>		
17-24	17	16.2
25-34	25	23.8
35-44	21	20
45-54	23	21.9
55+	19	18.1
<b>Age when first learned to ride</b>		
Younger than five	24	22.9
5 to 9	70	66.7
10 and older	11	10.5
<b>Average riding distance per week (in km)</b>		
Less than 10	6	5.7
10-30	6	5.7
31-100	40	38.1
101-200	37	35.2
Over 200	16	15.2
<b>Previous riding skills training</b>		
Yes	20	19.

No	80	76.2
Unknown	5	4.8
<b>Purpose of journey on crash day</b>		
Recreational	31	29.5
Commuting	51	48.6
Competition	4	3.8
Other (shopping, social, etc.)	19	18.1
<b>Helmet use at time of the crash</b>		
Yes	87	82.9
No	18	17.1
<b>Assistance required immediately after the crash</b>		
None- injuries but rode home	38	36.2
Left the scene by car/taxi	15	14.3
Treated at the scene	2	1.9
Hospital and not admitted	41	39
Hospital and admitted	9	8.6
<b>Reported to the police</b>		
Yes	3	2.9
No	102	97.1
<b>Total</b>	<b>105</b>	<b>100</b>

Table 2 shows the various types of on-road single-vehicle cyclist crashes with the majority occurring as a result of the cyclist losing control of the bicycle. Loss of control crashes on straight sections of the road accounted for over half of these crashes followed by collisions with permanent obstruction on the road (i.e. road furniture and elevations (17%) and loss of control on curved roads or while turning (14%.3).

**Table 2.** Types of on-road single-vehicle cyclist crashes

		<i>N</i>	%
Out of control on straight		55	52.4
Struck permanent obstruction on road		18	17.1
Out of control on curved road or turning		15	14.3
Off straight path to left		3	2.9
Struck object		3	2.9
Other		11	10.5
Total		105	100

Three cyclists, two who lost control on straight and one who struck permanent obstruction on the road, reported that they have done so to avoid another road user. One tried to avoid a passing car, the other a parked car and the third a passing pedestrian. Almost a quarter of cyclists involved in on-road single-vehicle crashes (24.8%) reported surface characteristics as contributing factors to the crash. These include irregular surface (9.5%), wet or slippery surface (8.6%), and loose gravel/sand/debris (6.7%).

Cyclists' behavioural factors such as distraction (21%), speeding (16.2%) and alcohol (5.7%) were also reported. Other contributing factors included those related to bike failure such as brake failure, Tyre/wheel defect and chain problems, which were reported by 19% of cyclists. Nearly half of cyclists reported carrying extra weight (mostly backpacks but three were carrying shopping bags) that might have affected their balance at the time of the crash.

**Table 3.** Contributing factors to single-vehicle cyclist crashes

	<i>N</i>	%
<b>Surface contributing factor</b>		
Irregular surface (lip/indent/ cracked surface/ pot holes)	10	9.5
Wet & slippery surface	9	8.6
Loose gravel /sand/debris	7	6.7
Total road surface	26	24.8
<b>Bike failure</b>		
Brake failure	4	3.8
Tyre/wheel defect	8	7.6
Chain problems	3	2.9
Foot caught in cleats	5	4.7
Total Bike failure	20	19.1
<b>Other contributing factors</b>		
Carrying extra weight that might have affected balance	50	47.6
Speeding	17	16.2
Inattentive/Distracted	22	20.9
Tired	1	1
Affected by alcohol	6	5.7
<b>Total</b>	105	100

### 3 DISCUSSION

The study shows that half of single-vehicle on-road crashes were associated with commuting with another 30% occurring while riding for recreational purposes. The findings also show that about 90% of cyclists are regular cyclists riding an average of over 30Km per week with 54% riding over 100 km per week. The findings reflect the popularity of cycling for commuting and recreation purposes in Canberra but also the higher risk of injury due to higher exposure among regular cyclists.

The results of the study also show that most injurious on-road single-vehicle cyclist crashes resulted from the cyclist losing control of the bicycle (66.7%) with the rest mainly resulting from collisions with objects or permanent obstruction on the road. Similar findings were reported in previous studies [8, 14, 15]. The findings point to the importance of riding and bicycle handling skills in the safety of cyclists. However, the results of this study show that only 1 in 5 cyclists involved in on-road single-vehicle crashes undertook riding skills training. While there is some

evidence indicating that cycling skills training as part of broader bicycle safety programs are likely to improve safety knowledge and safe-riding behaviour, particularly among children [16, 17], very little is known about their impact on reducing injury risk in cyclists and further research is warranted in this area.

Poor road surface quality was reported by nearly quarter of those involved in on-road single-vehicle crashes as a contributor to the crash. This includes slippery or wet surfaces and irregularities in the surface such as loose gravel or debris as well as road bumps, pot holes and cracked surfaces. Road irregularities can cause a crash if the cyclist loses control or swerves to avoid them or by causing damage to the bicycle tire/rim. Slippery roads, related to loose gravel and wet surfaces, can cause skidding falls and were found to contribute to 15% of fatal bicycle injuries in Croatia [18], a similar proportion to that found in this study. A survey of injured cyclists in New Zealand also found that loose gravel and other surface irregularities caused the greatest proportion of single-vehicle bicycle crashes and that permanent road furniture did not appear to be a significant crash cause contributing to only a very small proportion of crashes [19]. Similar findings were reported in a prospective study of 1087 commuter cyclists in Belgium [14]. These findings point to the importance of prompt clearance of loose gravel, sand and other debris as well as better maintenance of parts of the roads frequently used by cyclists.

Bike failure was reported as a contributing factor to the crash by almost one in five cyclists involved in on-road single-vehicle crashes indicating that mechanical maintenance of bicycles should be part of educational cycling safety programs. The risks associated with carrying extra weight on the bicycle may also be considered as part of such programs as more than half of cyclists reported carrying extra weight (mostly backpacks) that might have affected their balance at the time of the crash. There is very little research into the role of carrying extra weight in bicycle crashes and such investigation is needed in order to inform education and awareness campaigns.

About one in six respondents who were involved in on-road single-vehicle cyclist crashes reported that their speeding had contributed to the crash. A slightly higher proportion reported being inattentive or distracted as a contributor to the crash. Anecdotal evidence points to the risk posed by speeding cyclists to themselves, pedestrians and other cyclists. The negative effects of listening to music and of using a mobile phone have recently been studied, albeit in a small sample of 25 cyclists [20]. A more recent study found that the use of portable electronic devices (to listen to music or talk on the phone) was only significant predictor of bicycle crashes in teens and young adults aged 12-34 years [21]. Much is still unknown about the full impact of speeding and distraction on cyclist crashes and further research is needed in order to develop effective countermeasures.

The study also found that 6% of those involved in on-road single-vehicle cyclist crashes reported that they had been drinking alcohol prior to the crash. This was much lower than the reported 12% of non-collision cycle crashes, that also included off-roads incidents, reported in a UK study that was based on a combination of hospital data and police reports [15], but similar to that reported in a Swedish study of older riders [22]. High level use of alcohol by various road users, including cyclists, has been found to increase the risk of crash and severity of the associated injury [4, 23, 24]. Alcohol use increases the bicyclist's risk of injury from falling more than from collision as the inebriated bicyclist is more likely to increase his own risk of injury than that of other road users [23]. It is argued that intoxication increases injury severity in cyclists because it is more likely to lead to careless behaviour, such as not wearing a helmet, which appears to lead to more severe injuries if a crash occurs [4]. A case control study carried

out in Maryland (USA) found that relative to an estimated BAC of less than 0.02 g/dL, the odds ratio of bicycling injury was 5.6 for a BAC of 0.02 g/dL or higher and 20.2 for a BAC of 0.08 g/dL or higher [25]. The contribution of cyclist behaviour including speeding, distraction and alcohol indicates the need of increased education among cyclists but also improved regulation and enforcement efforts.

Almost 1 in 10 on-road single-vehicle crashes in this study were severe enough to require the cyclist involved to be admitted to a hospital (8.6%) but only 3% were reported to the police. The findings confirm the under reporting of all cycling crashes, particularly single-vehicle bicycle crashes, in police crash statistics as highlighted by previous studies [26, 27]. Instead of relying on limited administrative databases, further in-depth investigation of risk factors of single-vehicle bicycle crashes should be based on well-designed naturalistic and/or epidemiological studies (i.e. case-control or cohort studies).

It is important to note that the recruitment strategy meant that participation in the study was limited to those who attended a hospital emergency department in the ACT. Cyclists with minor injuries and those who sought treatment from other medical services including general practitioners, physiotherapists and pharmacies were not included. Reliance on self-report might have been associated with some level of recall bias and under reporting of 'sensitive' information such as alcohol use.

#### 4 CONCLUSIONS

The study provides much needed insight into the circumstances of on-road single-vehicle crashes. The results indicate that most of these crashes result from the cyclist losing control of the bicycle and highlight the need for more research into the role of riding and bicycle handling skills training in preventing this type of crashes. The role of the road condition as an important contributor to this type of crashes also points to the need for improving maintenance of bicycle lane, paths and roads frequently used by cyclists, including the need for keeping them clean from debris, gravel and sand. The findings of the study also indicate the need for further investigation of the impact of carrying extra weight, speeding and distraction among cyclists in order to develop appropriate strategies to reduce the burden of on-road single-vehicle and overall cyclist crashes.

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