



Severe bicycling injury risk factors in children and adolescents: A case–control study



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ABSTRACT

Background: Bicycling is the most common cause of sports and recreation injury in children and adolescents; yet, there is limited evidence on the factors associated with severe bicycling injuries in youth.

Methods: Case–control study of injured bicyclists less than 18 years old seen in seven emergency departments (EDs) from May 2008 to October 2010. Cases were bicyclists hospitalized after their ED visit (severe injury). Controls were bicyclists seen and discharged from the ED (non-severe injury). Personal, environmental, and crash characteristics were collected by interview. Injury data were collected from medical charts. Crude and adjusted odds ratios (ORs) and 95% confidence intervals (CIs) from logistic regression were used to estimate the odds of hospitalization associated with risk factors. Multiple imputation techniques were employed to address missing data.

Results: There were 1470 participants including 119 cases. Those ages 13–17 had the highest proportion (23%) of severe injuries resulting from motor vehicle [MV] collision. In models including age, sex and MV collision, being male (OR: 2.02; 95% CI: 1.21–3.38), not wearing a helmet (OR: 2.18; 95% CI: 1.43–3.31) and MV collision (OR: 3.91; 95% CI: 2.26–6.78) were significant risk factors for severe injury. Riding on a paved surface (OR: 0.63; 95% CI: 0.41–0.97) and utilitarian (school, work) bicycling (OR: 0.44; 95% CI: 0.2–0.94) decreased injury risk. Results were similar, apart from utilitarian bicycling (OR: 0.49; 95% CI: 0.22–1.06), after imputation for missing data.

Conclusion: Bicycle–MV collisions increase severe injury risk in youth, and adolescents are often injured in these events. This suggests separating bicyclists from MVs or traffic calming strategies could improve safety.

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Abbreviations: CI, confidence interval; ED, Emergency Department; MV, motor vehicle; OR, odds ratio; RA, research assistant.

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1. Introduction

Bicycling improves mental and physical health, reduces the risk of diabetes and obesity and reduces air pollution (Andersen et al., 2000; Reynolds et al., 2009; de Hartog et al., 2011). Conversely, bicycling is the most common cause of sport and recreation injury in those under 19 years old (Rivara and Grossman, 2004), the fourth-leading cause of hospitalizations and sixth leading cause of unintentional injury deaths in Canada for those under age 15

(Public Health Agency Of Canada, 2006). Children and adolescents have the highest rates of hospitalization for bicycle injuries (Jacobsen et al., 2009; Boufous et al., 2011). Given the popularity of cycling as an alternative mode of transportation, understanding risk factors for injury, especially severe injury, is important.

A number of studies have identified factors associated with severe injuries among bicyclists, though few have focused on children and adolescents and simultaneously examined a comprehensive list of potentially modifiable characteristics. Acton et al. (1995) noted that among children less than 15 years old, males had greater fatality rates than females and rates were highest between 12 and 14 years of age. Linn et al. (1998) found that motor vehicle involvement increased the odds of hospital admission 5-fold in their series of emergency department reported injuries among those under 19 years old. For those under 21 years old, Shah et al. (2007) noted the greatest rates of bicycle-related hospitalization for those 10–13 years old and that boys had higher rates than girls. Adolescents 15–18 years old had bicycling fatality rates over 4 times greater than those under 15 years old and those who sustained an injury on the street had an increased risk of hospitalization and death in the study by Mehan et al. (2009). Finally, Siman-Tov et al. (2012) identified strong relationships between motor vehicle involvement and a number of severe injury indicators (intensive care unit admission, length of hospital stay, rehabilitation and mortality) in those under 18 years of age.

Other studies have not restricted their analyses to children and adolescents in the search for severe bicycle related injuries. Rivara et al. (1997) noted an increased risk of serious injury in those under 13 and those 40 and older compared with 20–39 year olds. They also found an increase in the likelihood of severe injury with greater self-reported speed and with motor vehicle collisions (Rivara et al., 1997). Fatalities were associated with being male, motor vehicle collisions, and greater self-reported speed while helmet use reduced risk (Rivara et al., 1997). The likelihood of a severe injury due to a single bicycle crash was lower in municipalities with more bicycling and higher among those 25 and older in the study by Schepers (2012). Based on police traffic collision reports, Kim et al. (2007) noted a relationship between bicyclist fatalities and greater vehicle speed, inclement weather, truck involvement, motor vehicle and bicyclist intoxication and being 55 and older. Boufous et al. (2012), however, again using police traffic collision reports, found that severe injuries and fatalities were associated with adult age groups, dark conditions, greater location speed limits, rural locations, curved roads, certain crash types (e.g., vehicles collided from opposite directions) and no helmet use.

The most common mechanism of injury is a fall or loss of control (Rivara et al., 1997; Jacobsen et al., 2009); although, as noted above, a collision with a MV is associated with more severe injury and death (Cushman et al., 1990; Acton et al., 1995; Rivara et al., 1997; Linn et al., 1998; Kim et al., 2007; Jacobsen et al., 2009). Helmets reduce head, brain and severe brain injuries for all types of crashes (Finvers et al., 1996; Rivara et al., 1997; Attewell et al., 2001; Thompson et al., 2004; Amoros et al., 2012) and incorrect bicycle helmet fit increases head or facial injury risk (Rivara et al., 1999; Romanow et al., 2014).

To summarize, sex (males), age (adolescents), and motor vehicle involvement have been found to increase the risk of a severe bicycling injury in studies on children and youth. In those investigations examining risk factors for severe injuries among all age groups, these same factors, along with helmet use, the number of bicyclists, vehicle speed, weather conditions, bicyclist intoxication, time of the day, location speed limit, road type and rural location influenced severe bicyclist injury risk. Given the lack of comprehensive analytic studies focused on children and adolescents, the objective of this investigation was to simultaneously

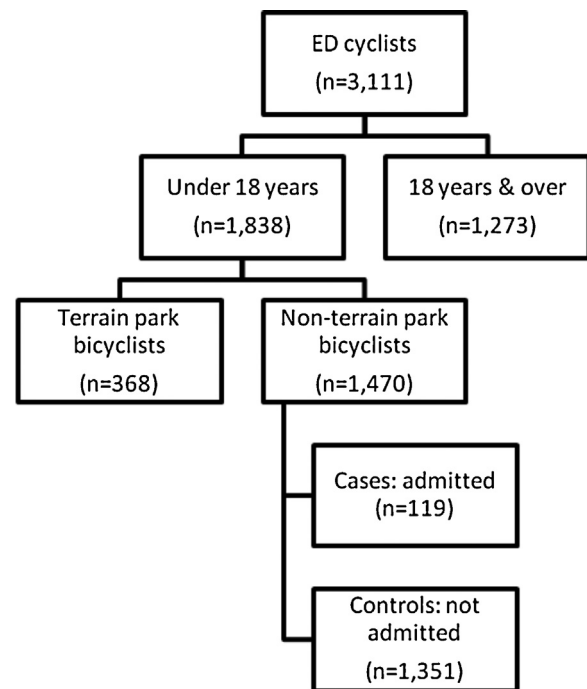


Fig. 1. Case-control recruitment and selection.

examine a wide range of potential risk factors for severe bicycling injuries in youth.

2. Methods

2.1. Study population

Study participants were bicyclists under the age of 18 who presented to one of seven EDs in Calgary (Alberta Children's Hospital, Foothills Medical Centre, Peter Lougheed Centre, Rockyview General Hospital) and Edmonton (Stollery Children's Hospital, University of Alberta Hospital, North East Community Health Centre) between May 2008 and October 2010. These individuals were originally part of a larger study of risk factors for motor vehicle related and severe injuries in relation to visibility aid use among all age groups (Hagel et al., 2014). Calgary and Edmonton are Alberta's two largest cities with populations of approximately 1 million and 800,000 in 2010 according to civic websites (City Of

Table 1

Distribution of body region injuries amongst controls (non-admitted) and severe cases (admitted).

	Injury controls	(%)	Severe cases	(%)	Total
Head	389	(23.7)	48	(27.1)	437
Neck	12	(0.7)	0	(0)	12
Trunk	99	(6.0)	36	(20.3)	135
Upper extremity	818	(49.9)	57	(32.2)	875
Lower extremity	322	(19.6)	36	(20.3)	358
Total	1640		177		1817 ^a

This table does not include those who had recorded diagnosis of multiple injuries where body region was not specified.

^a Accounts for all injuries of all individuals when multiple injuries have been incurred.

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