Mountain bike terrain park-related injuries: an emerging cause of morbidity

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Abstract

This case-control study describes the profile of bicyclists injured in mountain bike terrain parks (MBTP), and examines risk factors for severe injury among MBTP riders. Cases were hospitalized bicyclists injured in MBTPs. Controls were bicyclists injured in MBTPs who were discharged from the emergency department. No significant differences were observed in the distribution of age and sex between cases and controls. A higher proportion of cases compared with controls suffered a head injury (22%), fracture (41%), or internal organ injury (32%). Controls suffered a higher proportion of superficial injuries (26%), sprains (10%), or wounds (16%). Upper extremity protective equipment (e.g., elbow or shoulder pads) was used more by cases than controls (23% vs. 11%, p=0.03). Riders who self-reported cycling faster than usual had significantly higher risk of severe injury compared with others. The risk of severe injury may be reduced by encouraging bicyclists to control their speed, or by modifying MBTP design to limit the opportunity to gain speed.

Keywords: bicycling, wounds and injuries, epidemiology, protective devices

1. Introduction

Mountain biking has rapidly grown in popularity since its inception in the late 1970s (Chow & Kronisch, 2002). This is demonstrated by increasing numbers of competitive and recreational mountain bikers, the development of the sport into several sub-disciplines, such as cross-country, downhill, dual slalom, and four cross events, and more recently, the expansion of mountain biking as a commercial enterprise with the emergence of mountain bike terrain parks (MBTP). These parks are open to the public and all skill levels. They often include chair lift access, where riders are transported up the slope, and then bicycle downhill. MBTPs may create additional risks for injury in mountain bikers that differ from traditional off-road terrain because bicyclists ride downhill at high speeds and encounter various types of environmental and man-made obstacles.

Previous mountain bike injury research has focused on competitive riders. These studies have shown that the majority of injuries occur while riding downhill, and it is suggested that man-made features may lead to higher injury rates (Kronisch, Pfeiffer, Chow, & Hummel, 2002). The limited information available on recreational mountain bikers suggests that as many as 85.7% of riders report having sustained an injury in the previous 12 months (Kronisch & Rubin, 1994). While the majority of these injuries are minor (e.g., abrasions, contusions, soft tissue injuries, etc.), severe injuries do occur, including those that require emergency department (ED) visits, hospitalization and/or operative intervention (Kim et al., 2006).

One study examining the epidemiology of acute mountain bike injuries in recreational bicyclists at a public off-road bicycling facility reported an overall injury rate of 1.54/1000 biker

exposures (Aitken, Biant, & Court-Brown, 2011). Two thirds of injured riders reported suffering wounds (e.g., incised wounds, lacerations, abrasions), while other injuries such as fractures and soft tissue injuries (e.g., bruising, muscular injury, injury to soft internal organs) occurred in one-third of cases. Nearly half of all injuries occurred in the facility's "freeride park" (Aitken et al., 2011), an indication that areas designed with man-made obstacles and features that encourage doing jumps and stunts may pose additional risks.

Prior research has included mainly injured adult bicyclists; however, MBTPs cater to all ages including young, inexperienced bicyclists. Most MBTPs require the use of bicycle helmets, yet a variety of helmet styles exist including full-face and BMX, and the comparative effectiveness of different helmet styles remains unknown. The use of other protective equipment such as shin and elbow pads, chest protectors, and "body armour" varies, and the effect of this equipment on injury outcomes has not been examined.

The purpose of this study was to describe the profile of MBTP riders and their injuries, and to examine risk factors for severe injury among MBTP bicyclists. In addition to demographics, injury circumstances, and experience, information on helmet type and protective equipment use was documented to describe the use of safety equipment in the recreational MBTP rider population.

2. Methods

2.1 Participant recruitment

Study participants were drawn from participants recruited for a broader study on bicycling injury risk factors. The study recruited bicyclists who presented to one of seven EDs from May 2008 to

October 2010. The study sites included the Foothills Hospital, Rockyview Hospital, Peter Lougheed Centre, and Alberta Children's Hospital in Calgary, Alberta, and the Stollery Children's Hospital, University of Alberta Hospital, and Northeast Community Health Centre in Edmonton, Alberta. Data for this sub-study are restricted to patients treated at study sites in Calgary given this city's closer proximity to several MBTPs. The Calgary sites represent all hospital EDs in the city, including the only paediatric hospital (Alberta Children's Hospital), and three adult EDs including the designated regional trauma centre (Foothills Hospital). Participants were interviewed in person or by telephone, about the circumstances surrounding their injury using a standardized questionnaire developed for the study (Appendix 1). The items included in the questionnaire were based in part on previous research on bicycle and motorcycle injuries (Hagel et al., 2007; Wells et al., 2004). Before being implemented, the questionnaire was pilot tested with a convenience sample of 34 bicyclists and members of the research team. Feedback from the pilot testing phase was integrated into the final questionnaire, including the addition of questions relating to protective equipment use and helmet type (i.e., full-face vs. standard helmet).

Patients who reported that their injury occurred while riding in a MBTP were included. A MBTP was defined as a public, pay-for-use off-road bicycling facility. The MBTPs in the Calgary area have trails with varying levels of difficulty, which are graded similar to ski areas with green (beginner), blue (intermediate), and black (advanced) trail markings. Bicyclists who reported that the injury occurred during a race or competition were excluded. Injury information was captured through a review of the patient's medical chart and interviews. The interviews included the circumstances of the crash, the use of protective equipment (e.g., elbow pads, shin

guards and chest protectors), previous experience in the MBTP, and demographics. The variables included in the analysis were a combination of open-ended and fixed choice response questions.

The use of a case-control design was warranted given that the outcome of interest (i.e., severe MBTP-related injuries) was relatively rare and could easily be examined using an ED based study. Cases were defined as bicyclists who were hospitalized (i.e., admitted to an in-patient unit) and controls were bicyclists who were discharged from the ED. All patients provided written or verbal consent to participate in the study. The study was approved by the Conjoint Health Research Ethics Board at the University of Calgary and the Health Research Ethics Board at the University of Alberta.

2.2 Analysis

Interview and injury data were combined and entered into a research database (Microsoft Access 2007). Data were analyzed using STATA (v.10, Texas, U.S.A) statistical software. Descriptive data include counts and proportions with Pearson's chi^2 test p-values, as appropriate. For the relation between case and control status and injury types and body regions, each participant could have reported multiple injuries/regions. As such, we incorporated the Huber/White/Sandwich robust estimate of variance in a logistic regression of the relation between outcome (case-control status) and body region/injury type taking into account the non-independence of the observations (Rogers, 1993; Williams, 2000). The alpha level was set at 5% for all analyses.

Logistic regression was also used to identify predictors of severe injury using odds ratios (OR) and 95% confidence intervals (CI). We examined the effect of several potential risk factors

including the use of any protective equipment other than a helmet, riding a new bicycle, which was defined as having used the bike less than 10 times prior to the injury event, cycling speed, which was self-reported and grouped into ≥15 km/hr or less, cycling faster than usual, which was self-reported, and the type of manoeuvre being done at the time (if any) which was described by the cyclist.

The small number of cases in this study limited the number of potential independent variables that could be included in the logistic regression models. It has been recommended that as a general guideline, the number of independent variables included in a logistic regression model should not exceed 10% of the number of patients in the least frequent outcome category (cases) (Harrell, Lee, & Mark, 1996). However, it has also been suggested that this rule may be relaxed in order to more adequately examine potential confounding, and that an approach that includes 5-9 events per variable may be acceptable (Vittinghoff & McCulloch, 2007). We opted for this approach in order to examine the potential confounding effect of age, sex, and previous experience at the injury event location. Covariates included in the adjusted analysis were modelled using a backwards elimination approach, and were selected based on previous indication as potential risk factors for injury in bicycling or mountain biking specifically (Aitken et al., 2011; Kronisch et al., 2002; Kronisch & Rubin, 1994).

3. Results

3.1 Sample characteristics

The larger study included 3,113 patients visiting the Calgary and Edmonton EDs of which 409 (13%) bicyclists were injured in a MBTP and were included in this sub-study. Of these, 31 (7%) were hospitalized. Table 1 presents the demographic characteristics of injured bicyclists by case

and control status. Mean age for cases was 19 years (standard deviation [SD] 13.2), while mean age for controls was 15 years (SD 8.2). Those less than 14 years old represented 63% of the sample (51% of cases and 64% of controls). A greater proportion of cases than controls were injured while bicycling for personal recreation (84% vs. 78%), while a greater proportion of controls were part of a school group or camp (18% vs. 10%). None of these differences, however, were statistically significant.

3.2 Protective equipment use

We examined the use of non-helmet protective equipment such as elbow pads, shin guards and chest protectors in each group (Table 1). Twelve bicyclists reported wearing "full body armour", which we classified as a separate category from other types of protection. A greater proportion of cases than controls reported wearing upper (23% vs. 11%, p=0.03) extremity protection; however, no difference was identified with lower (42% vs. 30%, p=0.14) extremity protection or trunk protection (7% vs. 2%, p=0.12). There was a tendency for cases to wear more pieces of protective equipment; half of the cases wore at least one piece of protection, whereas 38% of controls did.

Most MBTPs require that helmets be worn. As such, helmet use was high; only 1 case and 1 control bicyclist were not wearing helmets at the time of the injury. Thirty-six percent of cases and 39% of controls were wearing a full-face helmet. This style of helmet has a face/mouth guard piece, similar to motocross helmets. Among those wearing a full-face helmet, 13% (21) suffered a head injury.

Table 1. Characteristics of the study sample

3.3 Injuries

A total of 465 injuries were sustained. There were 36 injuries in the case group, and 429 in the control group. A greater proportion of cases than controls suffered a head injury (19%), fracture (42%), or internal organ injury (28%). Controls suffered a greater proportion of superficial (28%), sprain/strain (9%), and wound injuries (14%). The most commonly injured body region for cases was the trunk (32%), while more controls injured upper (shoulder, arm, and wrist) (54%) and lower (hip, thigh, shin, ankle) (15%) extremities. The p-values, adjusted for clustering by participant, indicated that there were significant differences between cases and controls for the distribution of injury types (p=0.0028) and body regions (p=0.0001). Injury patterns for cases and controls are presented in table 2.

Table 2. Types of injuries and body regions by case-control status

3.4 Severe injury risk factors

Logistic regression was used to identify potential risk factors for severe injury. On univariate analysis, there was an indication of increased odds of severe injury among those riding a bicycle they had not ridden before (OR = 1.9; 95% CI: 0.9, 4.1). Those bicycling faster than they typically would in similar conditions had more severe injuries (OR = 2.5; 95% CI: 1.2, 5.3) compared with those riding at their habitual speed. We adjusted the analysis for age and sex, as both of these have been previously shown to be related to bicycling injury risk in both on and off-road bicycling (Aitken et al., 2011; Kronisch et al., 2002; Kronisch & Rubin, 1994). Age was dichotomized into young (≤14 years) and older (>14 years) groups for this analysis. We also adjusted for previous experience bicycling at the location (yes vs. no), as it could logically be expected that this factor may confound the relationship between potential risk factors and severe

injury. Bicycling faster than usual remained a significant risk factor once the analysis was adjusted for age, sex, and previous experience at the location (adjusted OR [aOR] = 2.8; 95% CI: 1.3, 6.1) (Table 3). Though the 95% confidence limits included the null value of 1.0, the adjusted odds ratio for jumping was 2.3 (95% CI: 0.7, 7.4), while the estimates for using a new bike (aOR = 2.1; 95% CI: 0.9, 4.8) and non-helmet safety equipment use (aOR = 1.6; 95% CI: 0.7, 3.4) suggested a potential relationship with hospitalization. As there were only small changes (<15%) in the OR estimates with the addition of potential confounders (age, sex, previous experience at the location), there was no evidence of confounding by any of these factors.

Table 3. Odds of severe injury in bicyclists injured in MBTPs

4. Discussion

Mountain bike terrain parks are a relatively recent sporting development and injury research in this area is in its infancy. Our study adds to the body of knowledge on mountain bike injuries by describing the profile of recreational bicyclists injured in MBTPs, and providing an understanding of the range of injuries sustained, outside the competitive setting. Our results expand our knowledge of the use of protective equipment among injured bicyclists, and highlight that bicycling at a speed faster than usual may lead to serious injury.

Similar to other mountain bike studies, our sample was primarily composed of males. Ninety percent of controls and 84% of cases were male. Males dominate participation in mountain biking, and thus, it is consistent that they suffer more injuries. In the competitive context, females have been found to have higher odds of injury (OR = 1.94; 95% CI: 1.17, 3.08) and were more likely to sustain fractures (OR = 4.17; 95% CI: 1.81, 9.29).(Kronisch et al., 2002) In our study, there was a greater proportion of females among cases compared with controls

(16.1% vs. 10.1%), consistent with previous research showing a greater risk among females, although the result was not statistically significant. Sex differences in the odds of injury may exist in the competitive setting and not in the recreational population. Females bicycling for recreation may be new to the sport and exercise a higher degree of caution than those riding in competition.

In this study the majority of cases (63%) involved children 14 years of age and younger. In fact, most of the cases and controls were 10-14 years old. This is consistent with other bicycling research which has shown that those 10-14 years old have higher injury rates (Mehan, Gardner, Smith, & McKenzie, 2009; Thompson, Thompson, Rivara, & Wolf, 1990). It may be that children in this group do in fact have higher injury rates in MBTPs, or that the high proportion of injuries in this group is a reflection of the demographics of terrain park users. Further research is required to determine the dangers posed by mountain biking in these youth age groups.

In our sample, 7% of bicyclists who presented to EDs were hospitalized. This is similar to the 6.3% of off-road bicyclists hospitalized in a study with data from the United States by Rivara et al. (F.P. Rivara, Thompson, Thompson, & Rebolledo, 1997), however, much lower than the 16% reported by Aitken et al at a mountain bike centre in Scotland (Aitken et al., 2011; F.P. Rivara et al., 1997). The higher percentage of hospitalized bicyclists in the latter study may be related to differences in admission criteria among countries. In our study, admission criteria were likely similar for all sites given the restriction of data collection to a single health region over a limited time period. All sites were staffed by full-time emergency physicians who are not permitted to write admitting orders; decisions to admit were made by the consultant staff.

Overall, while there may a tendency to admit children with a lower injury threshold compared with adults, this would apply to all sites. Controlling for age in the analysis would have mitigated the potential effect of age-related differences in admissions. Fractures were the most common type of injury in our investigation, consistent with an ED-based study on mountain biking-related injuries by Nelson and McKenzie (Nelson & McKenzie, 2011).

Our study is one of the first to examine the use of protective equipment in MBTPs. We found case-control differences in the use of various types of protection with cases tending to wear more pieces of protective equipment. Half of the cases wore at least one piece of non-helmet protective equipment, whereas nearly 40% of controls did so. Similarly, Aitken et al. reported that 31% of injured bicyclists were wearing some form of body armour at the time of injury (Aitken et al., 2011). It may be that those who wear safety equipment are more inclined to engage in risky behaviour, a phenomenon known as risk compensation (Hedlund, 2000). If this were so, it is possible that those wearing protection would be more likely to suffer severe injuries. However, it is also possible that characteristics associated with risk taking behaviour, such as experience and ability, may also be related to protective equipment use as has been found for skiers and snowboarders (Cundy et al., 2010; Ruedl et al., 2010). If this is the case, without adjusting for these other factors, increased risk of severe injury may be attributed to other associated personal characteristics rather than the use of protective equipment. The results of our study indicate that those who wore protective equipment still suffered injuries to the protected body regions. This may suggest that certain types of equipment protect against minor injuries, but may not offer as much protection for more severe injuries such as fractures. Further work on the role of protective equipment use and effectiveness in MBTPs is required.

Previous bicycling injury research has found that bicyclist speed is a risk factor for severe injury (F. P. Rivara, Thompson, & Thompson, 1997), and mountain bike studies have highlighted that riding downhill results in more injuries, and increased odds of severe injury compared with flat and uphill riding (Kronisch, Pfeiffer, & Chow, 1996; Kronisch et al., 2002; Kronisch & Rubin, 1994). We found that bicycling faster than usual resulted in a 2.6-fold increase in the risk of hospitalization. Because speed is a modifiable risk factor, these results suggest that by encouraging or requiring bicyclists to slow down, severe injuries may be reduced. MBTPs that cater to recreational bicyclists could be designed in a way that limits the speed riders can gain by reducing the distance of straightaways, or choosing to build trails in areas that are not as steep.

4.1 Limitations

This was a small sub-study of a broader examination of risk factors for bicycling injury. The sub-study sample included bicyclists presenting to EDs in a single Canadian city, with a short bicycling season and relatively low incline bicycling terrain. The study is limited in that the data were not originally collected to specifically examine off-road bicycling. As such, some information that might have been interesting to examine such as the type of manoeuvre being performed was not recorded. We would also have liked to have information on bicyclist experience (e.g., years bicycling) beyond what we collected on previous experience in the terrain park. Additionally, we do not have a measure of exposure and therefore, injury rates as well as the rate of protective equipment use in this sample compared with the MBTP population in general cannot be estimated. Moreover, we cannot determine the role of fatigue in these crashes, since we did not ask bicyclists how many "runs" they had taken before the injury occurred. An

additional limitation is that we may not have captured all of the injuries sustained from recreational mountain biking in terrain parks because some bicyclists may have sought medical attention elsewhere (e.g., first aid stations, clinics). Finally, the self-report nature of the information on crash circumstances may be subject to recall and social desirability biases, especially if bicyclists were interviewed by telephone sometime after they were discharged from the ED. However, it is unlikely that recall bias would affect cases and controls differently and, as such, this potential non-differential misclassification would likely bias odds ratios toward the null.

5. Conclusions

This study provides information on injuries in a relatively new bicycling discipline. MBTPs are different from other off-road facilities, and may create additional risks given how they are built and what they are designed for. By focusing on recreational bicyclists this study was able to describe injuries in the major group of MBTP users. We found that a large number of riders wear protective equipment and/or full-face helmets. More research is needed to examine the protective effect of specific pieces of equipment, as well as different helmet types. Riding faster than usual was identified as a risk factor for severe injury and future studies should focus on various approaches to MBTP design and the risk associated with man-made features.

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Table 1. Characteristics of the study sample

	Case No. (%) (n=31)	Control No. (%) (n=378)	Chi^2 P-value
Gender			
Male	26 (83.9)	340 (89.9)	0.29
Female	5 (16.1)	38 (10.1)	
Age			
<10	2 (6.5)	34 (9.0)	0.82
10-14	14 (45.2)	208 (55.0)	
15-18	7 (22.6)	69 (18.3)	
19-24	2 (6.5)	15 (3.9)	
25-40	4 (12.9)	33 (8.7)	
>40	2 (6.5)	19 (5.0)	
Education level (maternal if <18 years)			
High school	8 (25.8)	62 (16.5)	0.24
Post-Secondary	23 (74.2)	296 (78.7)	
Unknown	0 (0.0)	20 (5.3)	
Annual household income			
< $70 000	4 (12.9)	44 (11.6)	0.53
>$70 000	16 (51.6)	254 (67.2)	
Unknown	11 (35.5)	80 (21.2)	
Previous experience in terrain park			
Yes	24 (77.4)	281 (74.3)	0.74
No	7 (22.6)	95 (25.1)	
Unknown	0 (0.0)	2 (0.5)	
Reason bicycling			
Fun or recreation	26 (83.9)	294 (77.8)	0.36
Camp or School	3 (9.7)	69 (18.3)	
Other	2 (6.4)	13 (3.4)	
Unknown	0 (0.0)	2 (0.5)	
Crash time of day			
00:01-10:00	0 (0.0)	7 (1.9)	0.09
10:00-12:00	12 (38.7)	75 (19.8)	
12:00-16:00	16 (51.6)	221 (58.5)	
16:00-24:00	3 (9.7)	68 (18.0)	
Unknown	0 (0.0)	7 (1.9)	
Protective equipment			
Face/neck protection*	1 (3.2)	20 (5.3)	
Upper extremity	7 (22.6)	40 (10.6)	
Lower extremity	13 (41.9)	114 (30.2)	
Trunk	2 (6.5)	8 (2.1)	

Full body armour* *	0	12 (3.2)
Missing	1 (3.2)	3(0.8)
Gloves	22 (71.0)	244 (64.6)
Missing	2 (6.5)	0 (0.0)
Clipless (“clipped in”)	1 (3.2)	12 (3.2)
Missing	0 (0.0)	2 (0.5)
Helmets		
Yes	30 (96.8)	377 (99.7)
Full face	11 (35.5)	146 (38.6)
	(n=30)	(n=374)

*Other face and neck protection includes a chin guard and a neck brace

**Full body was described by 12 participants as a type of protective equipment. Information was not provided as to what specific body regions comprised full armour, and thus it was included as its own category of equipment.

Table 2. Types of injuries and body regions by case-control status

	Case No. (%)	Control No. (%)	Chi^2 P-value
Injury types	**(n=36)** [a]	**(n=431)** [a]	0.0028[c]
Head injury[*]	7 (19.4)	50 (11.6)	
Fracture	15 (41.7)	158 (36.7)	
Superficial[†]	1 (2.8)	122 (28.3)	
Sprain/ Strain[††]	1 (2.8)	39 (9.0)	
Open wound[†††]	2 (5.6)	60 (13.9)	
Injury to internal organ	10 (27.8)	0 (0.0)	
Unknown (left without being seen)	0 (0.0)	2 (0.5)	
Body regions	**(n=34)** [b]	**(n=430)** [b]	0.0001 [c]
Head/neck/face	10 (29.4)	88 (20.5)	
Trunk[¥]	11 (32.4)	27 (6.3)	
Upper extremity[∞]	10 (29.4)	233 (54.2)	
Lower extremity[§]	2 (5.9)	63 (14.7)	
Multiple injuries of more than one body part	1 (2.9)	17 (4.0)	
Unknown (left without being seen)	0 (0.0)	2 (0.5)	

[a] n= total number of injuries sustained in case and control groups

[b] n= total number of body regions injured (i.e. if two injuries occurred to the same body region, region is only counted once)

[c] Adjusted for clustering by participant

*Head injury includes concussion, intracranial injury, and minor head injury

[†]Superficial includes abrasion, soft tissue injury, and contusion

[††]Sprain/Strain includes dislocation and injury to muscle or tendon

[†††]Open wound includes laceration and infection/cellulites to wound

[¥] Trunk includes the spine, thorax, upper back, abdomen, lower back, pelvis, and perineum and ano-genital area

[∞]Upper extremity includes shoulder, clavicle, upper arm, elbow, wrist, hand, and finger

[§]Lower extremity includes hip, thigh, knee, lower leg, ankle, foot, and toes

Table 3. Odds of severe injury in bicyclists injured in MBTPs

	Crude odds ratio	**95% CI**	**Adjusted odds ratio***	**95% CI***
Use of safety equipment (other than helmet)	1.6	0.8-3.4	1.6	0.7-3.4
New bike	1.9	0.9-4.1	2.1	0.9-4.8
High speed (>15km/hr)	0.7	0.3-1.6	0.7	0.3-1.5
Speed faster than usual	**2.5**	**1.2-5.3**	**2.8**	**1.3-6.1**
Jumping (aerial manoeuvre)	2.4	0.8-7.5	2.3	0.7-7.4

*Odds ratios are adjusted for age (≤14 years vs. >14 years), sex, and previous experience (yes vs. no) at the location.

Appendix 1

Cyclist Data Collection Form

Interviewer Name: _____ Cyclist Initials: _____

Date of Interview: ___ / ___ / _____ Start Time: _____ Treatment Site: _____
DD / MM / YEAR Finish Time: _____

Note to interviewer: Ask the injured cyclist (or proxy) the questions in SECTIONS 1 to 8. You will complete SECTION 9 with information from the injured cyclist's medical chart.

SECTION 1: CRASH DETAILS

1.1a What exactly happened in the crash? (Interviewer to write notes as the subject describes the crash)

_____

_____

_____

_____

1.1b What was the exact location of the crash? (ie. Street location, community, town/city) _____

_____

1.2 What time of day was the crash? __ __ : __ __ (00:00 - 23:59)

1.3 What was the date? ___/___/___ DD/MM/YEAR

1.4 What day of the week was it? (Circle number)

1 Monday
2 Tuesday
3 Wednesday
4 Thursday
5 Friday
6 Saturday
7 Sunday
8 Don't know

1.5 What was the weather like at the time of the crash? (Circle all that apply)

1 Clear
2 Cloudy/overcast
3 Light rain
4 Heavy rain
5 Hail/sleet
6 Snow
7 Fog/Smog/Smoke/Dust
8 High Wind
9 Other, please specify_____
10 Don't know

1.6 What were the light conditions at the time of the crash? (Circle number)

1 Daylight
2 Sunglare (bright sun shining in eyes)
3 Dawn or dusk and street lights on
4 Dawn or dusk and no street lights on
7 Dawn or dusk and don't know about lights
5 Dark and street lights on
6 Dark and no street lights on
8 Dark and don't know about lights

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9 Other, please specify_____
10 Don't know

1.7 Where were you riding at the time of the crash? (Circle number)

1 Road
2 Sidewalk
3 Bike path
4 Offroad
5 Other, please specify_____
6 Don't know

1.8 On what kind of surface were you riding? (Circle all that apply)

1 Pavement
2 Gravel
3 Dirt
4 Grass
5 Other, please specify _____
6 Don't know

1.9 What were the surface conditions at the time of the crash? (Circle all that apply)

1 Dry
2 Wet
3 Slush/snow/ice
4 Loose surface material
5 Muddy
6 Hole/ruts/bumps
7 Other, please specify_____
8 Don't know

1.10 Did something go wrong with your bicycle? (Circle all that apply)

1 The brakes didn't work
2 The chain fell off
3 A wheel fell off
4 A tire went flat
5 Something got caught in the spokes
6 Other, please specify _____
7 Don't know
8 Nothing went wrong with the bicycle

1.11 What type of crash was it? (Circle all that apply)

Non-motor vehicle related

2 Slid down/fell off bicycle – no vehicle involved
4 Impact with an animal
5 Impact with a pedestrian
6 Impact with another bicycle
10 Impact with a pole or tree
11 Impact with a street curb
12 Other, please specify _____

Motor vehicle related

1 Slid down/fell off bicycle – because of a vehicle (but no impact with the vehicle)
3 Impact with a parked or stationary vehicle
7 Impact with a moving car
8 Impact with a moving light truck or van
9 Impact with a moving bus or heavy truck
14 Other, please specify _____

13 Don't know
15 Refused to answer *("choose not to answer")*

1.12 Were you at any fault in the crash? (Circle number) *Read out the response choices*

1 Yes
2 No
3 Partially
4 Don't know
5 Refused to answer ("*choose not to answer")*

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1.13 How fast do you think you were going when you crashed? (Circle number)

1 I was stopped
2 less than 5 km/hr
3 5 to less than 10 km/hr)
4 10 to less than 15 km/hr
5 15 to less than 20 km/hr
6 20 to less than 25 km/hr
7 25 km/hr and greater
8 Don't know

1.14 What was the speed limit at the location of the crash? _____ km/hour. [ ] Don't know [ ] No speed limit

1.15 Were you cycling faster than you typically would in similar conditions? (Circle number)

1 Yes
2 No
3 Don't know
4 Refused to answer *("choose not to answer")*

1.16 Approximately how many kilometers had you cycled that ride before you crashed?_____Kms [ ] Don't know

1.17 Did you use your brakes just before the crash occurred? (Circle number)

1 Yes
2 No
3 Don't' know
4 Other, please specify _____

1.18 What was your main reason for cycling at the time of the crash? (Circle number)

1 Going to/from work
2 Going to/from visiting friends or family
3 Going to/from a party or a bar
4 Cycling for fun or recreation/exercise
5 Going to/from shopping
6 Going to/from playing a sport
7 Going to/from school
8 Other, please specify _____
9 Don't know
10 Refused to answer *("choose not to answer")*

1.19 Had you previously cycled at the location of the crash? (Circle number)

1 Yes
2 No
3 Don't know

IF YES

1.20 In the last year how many times had you cycled at the location of the crash? (Circle number)

1 One to 3 times
2 Four to 10 times
3 Eleven to 20 times
4 More than 20 times
5 Don't know

1.21 Was another person on your bicycle with you at the time of the crash? (i.e., were you "doubling" someone)

(Circle number)

1 Yes
2 No
3 Don't know

4 Refused to answer *("choose not to answer")*

1.22 Were you riding with anyone else at the time of the crash? (Circle number)
1 Yes .....GO TO Question 1.23
2 No.....GO TO Question 1.26
3 Don't know .....GO TO Question 1.26

IF YES
1.23 Who were you riding with? (Circle number)
1 Children
2 Adults
3 Adults and children
4 Other, please specify _____

If cyclist is a CHILD (<18 years): ask 1.24 <u>OR</u> 1.25:

CHILD was <u>riding with an adult</u> (or adults and children):

1.24 Was the adult (or one of the adults) a parent or legal guardian? (Circle number)
1 Yes 3 Don't know
2 No 4 Other, please specify _____

<u>OR</u>

CHILD was <u>riding with another child</u> (or children):

1.25 Were you being supervised (watched) by a parent or legal guardian who was nearby? (Circle number)
1 Yes 3 Don't know
2 No 4 Other, please specify _____

1.26 Were you using any electronic devices while riding your bicycle? Such as…
1 An iPod, MP3 player, radio, walkman or other portable media device ..... GO TO 1.27
2 A cell phone or smart phone (e.g. a Blackberry) ..... GO TO 1.28
3 A camera or video-camera
4 A GPS device
5 A bicycle computer
6 Other electronic device, please specify_____
7 No
8 Don't know

1.27 Were you using noise cancelling headphones?
1 Yes, with both earpieces in
2 Yes, with one earpiece in
3 No
4 Other, please specify _____
5 Don't know

1.28 How were you using your cell phone at the time of the crash?
1 Having a conversation i.e. talking or listening
2 Checking voicemail
3 Checking for text messages
4 Reading a text/email message
5 Composing a text/email message

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6 Hands-free use
7 Other, please specify _____
8 Don't know

SECTION 2: THE CYCLIST

2.1 Were you wearing a helmet? (Circle number)
1 Yes .....GO TO Question 2.2 3 Don't know.....GO TO Question 2.7
2 No.....GO TO Question 2.7 4 Refused to answer *("choose not to answer")* GO TO Ques. 2.7

2.2 What type of helmet was it? (Circle number) *Read out the response choices*
0 Bicycle, full face guard
1 Bicycle, no face guard
2 Other sport, please specify _____
3 Don't know

2.3 What was the main colour of your helmet?(write one colour)_____

2.4 Would you say your helmet was light or dark? (Circle number)
1 Light 3 Don't know
2 Dark

2.5 How did the helmet fit you? *Read out the response choices*
1 Excellent 4 Poor
2 Good 5 Don't know
3 Fair 6 Refused to answer *("choose not to answer")*

2.6 What happened to the helmet when you crashed? *Read out the response choices*
1 The helmet stayed centered on my head
2 The helmet tilted backwards on my head
3 The helmet shifted to one side of my head.
4 The helmet came off
_____ 7 Other, please specify
5 Don't know
6 Refused to answer *("choose not to answer")*

_____

2.6a Was the helmet damaged in the crash? (circle all that apply)
1 The helmet cracked, but stayed in one piece
2 The helmet broke into pieces
3 The helmet was scraped or scratched
4 The visor broke
5 Other, please specify_____
6 Don't know
7 The helmet was not damaged

2.7 Were you wearing any clothing with reflective material? (Such as a jacket with reflective strips on the arms)
1 Yes .....GO TO Question 2.8
2 No.....GO TO Question 2.9
3 Don't know ...GO TO Question 2.9

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2.8 Please describe the reflective clothing you were wearing.

REFLECTIVE CLOTHING DETAILS:

Type of clothing	Location of reflective material

2.9 Were you using any reflective articles that were not clothing? (Such as a reflector on a backpack or a reflector or light on your helmet)

1 Yes 3 Don't know
2 No

IF YES, what were they and where were they located? _____

2.9a Were you using any other safety or protective articles? (Such as elbow pads, a chest protector, or shin guards)

1 Yes 3 Don't know
2 No

IF YES, what were they? _____

2.10 From the **front**, what was the main colour of clothing on your **upper** body (waist up)?_____

2.11 Was it light or dark? (Circle number)

1 Light 3 Don't know
2 Dark

2.12 Was it fluorescent? (Circle number)

1 Yes 3 Don't know
2 No

2.13 From the **back,** what was the main colour of clothing on your **upper** body (waist up)? _____

2.14 Was it light or dark? (Circle number)

1 Light 3 Don't know
2 Dark

2.15 Was it fluorescent? (Circle number)

1 Yes 3 Don't know
2 No

2.16 Were you wearing a backpack?

1 Yes .....GO TO Question 2.17
2 No.....GO TO Question 2.19

3 Don't know ....GO TO Question 2.19

2.17 IF YES, what colour was it?

2.18 Was it light or dark? (Circle number)
1 Light 3 Don't know
2 Dark

2.19 What was the **main** colour of clothing on your lower body (waist down)? _____

2.20 Was it light or dark? (Circle number)
1 Light 3 Don't know
2 Dark

2.21 Was it fluorescent? (Circle number)
1 Yes 3 Don't know
2 No

2.22 What were you wearing on your feet? (Circle number)
1 Nothing
5 Flip flops
2 Sports sandals
3 Light shoes (e.g. running shoes)
4 Heavy shoes/boots
6a Cycling shoes that were clipped in (attached to pedal)
6b Cycling shoes that were not clipped in
7 Other, please specify_____
8 Don't know

2.23 Were you wearing gloves? (Circle number)
1 Yes 3 Don't know
2 No

SECTION 3: THE BICYCLE

3.1 Were you riding your own bicycle at the time of the crash? (Circle number)
1 Yes 3 Don't know
2 No 4 Refused to answer *("choose not to answer")*

3.2 Did the bicycle you were riding have training wheels? (Circle number)
1 Yes 3 Don't know
2 No

3.3 Was the bicycle damaged in the crash? (Circle number)
1 Yes 3 Don't know
2 No

3.4 What was the main colour of the bicycle?

3.5 Would you say it was light or dark? (Circle number)
1 Light 3 Don't know
2 Dark

3.6 Did the bicycle have any reflectors?

Front reflector?	☐ Yes	☐ No	☐ Don't know
Rear reflector?	☐ Yes	☐ No	☐ Don't know

Spoke reflector?	☐ Yes	☐ No	☐ Don't know
Pedal reflector?	☐ Yes	☐ No	☐ Don't know
3.7 Did the bicycle have a headlight?	☐ Yes	☐ No	☐ Don't know
IF YES:			
3.8 Was the headlight turned on?	☐ Yes	☐ No	☐ Don't know
3.9 Did the bicycle have a taillight?	☐ Yes	☐ No	☐ Don't know
IF YES:			
3.9a Was the taillight turned on?	☐ Yes	☐ No	☐ Don't know

SECTION 4: CYCLING EXPERIENCE

4.1 How many times have you ridden this specific bicycle? (Circle number)

1 Never ridden this bicycle before
2 Once or twice before
3 Three to five times before
4 Six to ten times before
5 More than ten times before

4.2a During the warmer months of the year, how often (on average) do you ride a bicycle? (Circle number)

1 Three days a week or more
2 One to 2 days a week
3 One to 3 days a month
4 Less than one day a month
5 Other, please specify _____
6 Don't know
7 Not at all

4.2b During the colder months of the year, how often (on average) do you ride a bicycle? (Circle number)

1 Three days a week or more
2 One to 2 days a week
3 One to 3 days a month
4 Less than one day a month
5 Other, please specify _____
6 Don't know
7 Not at all

4.3a During the warmer months of the year, how many kilometers (on average) do you ride a bicycle each week? (Circle number)

1 None
2 10 kms or less
3 11 – 20 kms
4 21 – 30 kms
5 31 – 40 kms
6 41 - 50 kms
7 51 – 60 kms
8 61 - 70 kms
9 Other, please specify_____
10 Don't know

4.3b During the colder months of the year, how many kilometers (on average) do you ride a bicycle each week? (Circle number)

1 None
2 10 kms or less
3 11 – 20 kms
4 21 – 30 kms
5 31 – 40 kms
6 41 - 50 kms
7 51 – 60 kms
8 61 - 70 kms
9 Other, please specify_____
10 Don't know

4.4 Do you have a job that requires you to ride a bicycle? (Circle number)

1 Yes
2 No
3 Don't know
4 Refused to answer *("choose not to answer")*

IF YES: 4.5 What is your job? _____

SECTION 5: OTHER FACTORS *(For children younger than 14 years old, omit questions 5.1 to 5.6)*

5.1 Did you drink any alcohol in the 12 hours before the crash? (Circle number)

1 Yes ..... GO TO Ques 5.2
2 No ..... GO TO Ques 5.5
3 Don't know ..... GO TO Ques 5.5
4 Don't remember ..... GO TO Ques 5.5
5 Refused to answer *("choose not to answer")* GO TO Ques. 5.5

IF YES: 5.2 How many hours before the crash did you **START** drinking? _____

5.3 How many hours before the crash did you **STOP** drinking? _____

5.4 What did you have to drink and how much? _____

_____

5.5 Did you use any marijuana or other similar drugs in the 12 hours before the crash? (Circle number)

1 Yes ..... GO TO Ques 5.6
2 No GO TO Ques 5.7
3 Don't know ..... GO TO Ques 5.7
4 Don't remember ..... GO TO Ques 5.7
5 Refused to answer *("choose not to answer")* GO TO Ques. 5.7

IF YES: 5.6 What drugs did you use and how much? _____

_____

ASK OF ALL CYCLISTS:

5.7 Did you take any prescription or over-the-counter (non-prescription) medications in the 12 hours before the crash? (Circle number)

1 Yes, prescription medication(s) only
2 Yes, prescription medication(s) and over the counter medication(s)
3 Yes, over the counter medication(s) only
4 No
5 Don't know

IF YES: 5.8 What did you take and how much? _____

_____

SECTION 6: DEMOGRAPHIC INFORMATION

Begin by saying: "The following are some demographic questions. This information is valuable to our study, but you are not obligated to answer. Any information that you give us will be kept private."

6.1 Your sex: (Circle number)

1 Female
2 Male

6.2 What is your age? _____years

6.3 About how tall are you? _____

6.4 About how much do you weigh?

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6.5 What ethnic group do you belong to? (Circle number) *Read out the response choices*

1 Caucasian
2 Aboriginal
3 Asian
4 Hispanic
5 African
6 Other, please specify _____
7 Don't know
8 Refused to answer *("choose not to answer")*

Choose the appropriate column (adult or child cyclist) for questions 6.6 to 6.8.

***Read out the response choices for 6.6, 6.7 and 6.8.*

ADULT CYCLIST (18 years of age or older)	**CHILD CYCLIST** (Less than 18 years of age)
6.6 What is your level of education? 1 No high school diploma 2 High school diploma 3 College/professional diploma 4 Trade certificate (journeyman) 5 University degree 6 Graduate degree 7 Other, please specify_____ 8 Don't know 9 Refused to answer *("choose not to answer")*	6.6 What is your mother's level of education? 1 No high school diploma 2 High school diploma 3 College/professional diploma 4 Trade certificate (journeyman) 5 University degree 6 Graduate degree 7 Other, please specify_____ 8 Don't know 9 Refused to answer *("choose not to answer")*
6.7 What is the average annual income of your household? 1 Less than $30,000 2 Between $30,000 and $49,999 3 Between $50,000 and $69,999 4 $70,000 or more 5 Don't know 6 Not applicable 7 Refused to answer *("choose not to answer")*	6.7 What is the average annual income of your household? 1 Less than $30,000 2 Between $30,000 and $49,999 3 Between $50,000 and $69,999 4 $70,000 or more 5 Don't know 6 Not applicable 7 Refused to answer *("choose not to answer")*
6.8 What is your marital status? (circle number) 1 Single (never married) 2 Married 3 Living with a partner 4 Separated or divorced 5 Widowed 6 Refused to answer *("choose not to answer")*	

SECTION 7: PAST BICYCLE CRASHES

(For this study, a crash means that you fell off your bike with an injury or the bicycle was damaged)

7.1 In the last 5 years, how many crashes have you had as a cyclist? (not counting the present crash)_____

7.2 What was the year of your most recent crash? (not counting the present crash) _____

7.3 Were you injured in the crash? (Circle number)

1 Yes ..... GOTO Question 7.4
2 No..... GOTO Question 7.8
3 Don't know ..... GOTO Question 7.8

IF YES: 7.4 Did you seek medical care? (Circle number)

1 Yes 3 Don't know
2 No

IF YES:
7.5 Where did you receive medical care?
1 Emergency Department
2 Walk-in-clinic
3 Family Doctor
4 Other, please specify_____
5 Don't know

7.6 Did this injury interfere with your normal daily activities? (Circle number)

1 Yes 3 Don't know
2 No

IF YES:
7.7 For how many days? _____ DAYS

7.8 Was your bicycle damaged? (Circle number)

1 Yes 3 Don't know
2 No

SECTION 8: ATTITUDES AND BEHAVIOURS

The final section is about attitudes and behaviours. I will read two opinion statements. **Please choose the statement that is most like you**. There are no right or wrong answers; we simply want your opinion.

1 A I would like to try mountain climbing.
B I think people who do dangerous things like mountain climbing are foolish.

2 A I'd never do anything that's dangerous.
B I sometimes like to do things that are a little scary.

3 A I would like to try to water-ski.
B I wouldn't want to water-ski.

4 A I would like to try surf-board riding.
B I would not like to try surf-board riding.

5 A I don't like doing things that I'm not sure how to do and that are a bit scary.
B I don't mind trying fun things that I'm not sure how to do and that are a bit scary.

6 A I would like to try jumping from a plane with a parachute.
B I would never try jumping from a plane with a parachute.

7 A I like to do tricks and try new things when riding my bike, even if they could be a bit dangerous.
B When I ride my bike, I don't like doing tricks or anything that might be dangerous.

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8	A	I think skiing fast down a snowy mountain would be dangerous.
	B	I think it would be fun to ski really fast down a snowy mountain.
9	A	I like to jump or dive off a diving board.
	B	I don't like the feeling I get when standing on a diving board.
10	A	I like to swim in water that is not over my head.
	B	I like to swim in deep water that is over my head.
11	A	Sailing on the ocean in a small boat would be dangerous and foolish.
	B	I think it would be fun to sail on the ocean in a small boat.

8.12 As we finish up, is there anything else about the crash that you would like included in the study? _____

_____

_____

8.13 May we contact you in the future to clarify any of the information you told us in this interview?
1 Yes ..... Ask patient for the contact information below.
2 No……...Thank the patient for participating.

8.14 May we contact you about taking part in future research related to this study?
1 Yes ..... Ask patient for the contact information below.
2 No……...Thank the patient for participating.

Telephone: _____
Best day and time to contact: _____

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SECTION 9: RESULT OF INJURY (To be collected from the patient's medical chart)

9.1 Please list all of the cyclist's injuries. Examples for each category are given below.

Injury	Nature of injury	Body part(s) involved
1		
2		
3		
4		
5		

NATURE OF INJURY

10 Superficial (e.g., bruise, abrasion)
11 Open wound/Laceration
27 Soft tissue
12 Fracture
13 Dislocation
75 Pulled elbow
14 Sprain or strain
15 Injury to nerve
16 Injury to blood vessel
17 Injury to muscle or tendon
18 Crushing injury
19 Traumatic amputation

20 Burn or corrosion
21 Frostbite
22 bite (with or without invenomation)
23 Electrical injury
24 Eye injury
25 Dental injury
26 Injury to internal organ

31 Foreign body in external eye
32 Foreign body in ear canal
33 Foreign body in nose
34 Foreign body in respiratory tract
35 Foreign body in alimentary tract
36 Foreign body in genito-urinary tract
37 Foreign body in soft tissue

41 Minor head injury
42 Concussion
43 Intracranial injury

50 Poisoning or toxic effect
51 Drowning or immersion
52 Asphyxia or other threat to breathing
53 Systemic over-exertion; heat/cold stress

BODY PART(S)

Head and Neck
110 Scalp, skull, head
120 Face (including ear)
130 Internal mouth
135 Specified head injury (specified by nature of injury)
140 Neck

Spine and Spinal Cord
200 Spine and/or spinal cord

Trunk
310 Thorax (incl. lungs, heart)
315 Upper back
321 Abdomen (incl. abdominal organs)
322 Lower back
323 Pelvis
324 Perineum and anogenital area

Shoulder and Arm
410 Shoulder
415 Clavicle
420 Upper arm
430 Elbow
440 Forearm
450 Wrist
460 Hand
470 Finger

Hip and Leg
510 Hip
520 Thigh
530 Knee
540 Lower leg
550 Ankle
560 Foot
570 Toe

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60 Multiple injuries of more than one nature
70 No injury detected
700 Multiple injuries of more than one body part
900 Body part NOT REQUIRED (e.g. systemic injury, no injury detected)

9.2 Injury Severity Score: _____

9.2a Blood alcohol level (if applicable)_____

9.3 Patient Disposition (Outcome)**:** (Circle number)
1 Left without being seen (LWBS)
2 Left against medical advice (LAMA)
3 Treated, follow-up PRN
4 Treated, follow-up required
5 Short stay unit, observation in emergency
6 Admitted to this hospital ☐ Ward ☐ ICU
7 Transferred to another hospital (specify) _____
8 Dead on arrival or died in emergency
9 Other, please specify _____

9.4 Questionnaire information obtained from (Circle all that apply)
1 Injured cyclist
2 Injured cyclist's parent or guardian
3 Other proxy respondent, please specify _____
4 Physician
5 Police officer
6 EMS worker

9.5 Place of Interview: (Circle number)
1 Emergency Department
2 Hospital Inpatient Unit
3 Telephone
4 Other, please specify _____