An Overview of Non-motor Vehicle Bicycle Crashes in Oregon

Heidi Purcell, MPH
CSTE Injury Epidemiology Fellow
Injury Prevention and Epidemiology Section
Public Health Division
Oregon Department of Human Services

Introduction

"While it is generally recognized that non-motor vehicle accidents occur with far greater frequency than bicycle/motor vehicle accidents, there is surprisingly little data on their incidence, consequences and causes."

Kenneth D. Cross. *Bicycle-safety education – facts and issues.* 1978

Definitions

- <u>Non-motor vehicle-related bicycle crash (NMV)</u>: a crash on a bicycle that does not involve a motor vehicle

    – (e.g. bicyclist falls from/on bike, or collides with object, another bicyclist, a pedestrian, animal, etc.)

- <u>Motor vehicle-related bicycle crash (MV)</u>: a crash on a bicycle that involves a motor vehicle

Gaps in Knowledge about NMVs

- Most studies of bicycle crashes focus on MVs
  - Do not distinguish between different causes and risk factors of NMVs & MVs
- Studies of NMVs generally focus on children
  - Helmet use studies, handlebar injuries, etc.
- Most bicycle crash data used in city/program planning comes from DOT and FARS
  - Excludes NMVs or crashes occurring off-road

NMV Bicycle Crash Study

- Objective: describe the frequency and risk factors for NMVs

- Methods: 3 data sources
  - Death certificates (Underlying causes V10-V11, V16-V18, V19.3, V19.8, V19.9)
  - Hospital discharge records (E826.1)
  - Pedal Cyclist Safety Survey

Oregon NMV Deaths, 2001-2005

- **24%** of fatal bicycle crashes (n=17)
  - 10 fell from bike, 5 collided with stationary objects, 2 collided with a pedestrian/animal
  - 77% died of head injuries, 18% neck injuries, and 18% chest/abdominal trauma[*]
  - 65% occurred during day
  - 70% occurred on a street, the rest on a bike path/trail
  - Only one noted alcohol as contributing factor

*Sum ≠ 100% due to decedents with multiple injuries

MV vs. NMV Hospitalizations
Oregon, 2002-2006

- Number of NMV hospitalizations 3 times MV

- NMVs 9th leading cause of injury hospitalizations
  - 5th leading cause of traumatic brain injury (TBI) hospitalizations

- < 1/3 in children under age 18

	NMV	MV
Average Annual Frequency	307	107
Males	78%	81%
Mean age	35 years	33 years
Age Distribution		
< 18 years	29%	28%
18-34 years	21%	26%
35-49 years	23%	25%
50 and over	27%	21%

MV vs. NMV Hospitalizations Oregon, 2002-2006

	NMV N=1533	MV N=533
Leading Diagnoses		
Upper limb fractures	376 (25%)	124 (23%)
Lower limb fractures	254 (17%)	202 (38%)
Intracranial injuries	314 (21%)	142 (27%)
Number of TBIs	470 (31%)	223 (42%)
Number of hip fractures	135 (9%)	21 (4%)
Total charges in millions	$27.1	$14.2
Median charges per person	$12,800	$17,200

Pedal Cyclist Safety Survey

- **Study Goals**: To examine risk factors associated with NMVs

- **Methods**:
    - Cross-sectional
    - Via email and internet
    - Convenience sample of bike commuters
    - Recruited through local bicycling group digest
    - Descriptive and logistic regression analyses performed to assess differences between crashers and non-crashers

Demographic Characteristics

	Study Population N=321	Oregon Population
Males	58%	50%
Age Group		
< 18 years	0%	23%
18-34 years	24%	23%
35-64 years	71%	41%
65+ years	5%	13%

Factors in Crashes Reported by Respondents

Has experienced a NMV as an adult	164 (51%)
Has experienced a NMV crash in prior 2 years	**84 (26%)**
Factors in crashes occurring in prior 2 years (N=84)	**N (%)**
Occurred on roadway	56 (67%)
Fall from bike	45 (54%)
Collision with stationary object	31 (37%)
Occurred during daylight hours	71 (85%)
Environmental Factors	
Cracks, ruts, potholes, or uneven road surface	26 (31%)
Bad weather – rain, snow, ice, etc.	21 (25%)
Debris in road	17 (20%)
MAX, streetcar or RR tracks	17 (20%)
Obstructions in pathway	11 (13%)
Other Factors	
High speed ($\geq$15 mph)	31 (37%)
Turning	30 (36%)
Braking	17 (20%)
Another person or animal appeared in pathway	6 (7%)
Mechanical failure	4 (5%)
Distracted rider	4 (5%)

Risk/Protective Behaviors

	N (%)
Wears a helmet while riding	316 (98%)
Uses hand signals while riding	311 (97%)
Uses hand brakes	311 (97%)
Always slows at uncontrolled intersections	305 (95%)
Uses front and rear lights at night	299 (93%)
Refrains from using cell phone while riding	283 (88%)
Refrains from listening to music/wearing headphones while riding	282 (88%)
Wear bright or reflective clothing at night	228 (71%)
Uses a bell to alert others of presence	161 (50%)
Uses a handlebar or helmet mounted mirror	126 (39%)
Confident riding in heavy traffic w/out a bike lane	116 (36%)
Always makes complete stop at traffic signs and signals	115 (36%)
Rides on the sidewalk sometimes or often	69 (22%)
Rides against traffic sometimes or often	5 (2%)

Univariate Analyses of Exposure Variables*† (N=321)

Variable†	Odds Ratio	95% CI	P-value
Riding habits:			
Bicycle sole source of transportation	1.03	(0.48, 2.21)	0.943
Bicycle commuter	**0.58**	**(0.34, 0.98)**	**0.041**
Rides for exercise and recreation	1.29	(0.72, 2.32)	0.391
Both a commuter and recreational rider	1.27	(0.82, 1.97)	0.283
Solely a "weekend" rider	0.96	(0.19, 4.18)	0.957
Rides often year-round	**1.61**	**(1.03, 2.52)**	**0.036**
Average weekly mileage < 100 miles	1.00		
Average weekly mileage = 100+ miles	**3.11**	**(1.81, 5.37)**	**< 0.001**
Rides most often in:			
Morning or afternoon	0.72	(0.22, 2.32)	0.580
Evening or after dark	1.09	(0.70, 1.70)	0.710
Often rides on:			
High-volume streets w/out bike lane	1.34	(0.80, 2.22)	0.265
High-volume streets w/bike lane	0.89	(0.53, 1.48)	0.649
Low-volume streets	1.54	(0.80, 2.95)	0.195
Off-road paths	1.34	(0.85, 2.09)	0.204

*Outcome: Ever experiencing a NMV in adult life
†Univariate associations of behavioral risk factors and demographic characteristics also examined

Multivariate Associations with NMVs

Variable	Odds Ratio	95% CI	P-Value
Gender			
Females	1.00		
Males	1.70	(1.01, 2.87)	0.048
Rides mostly for commuting purposes	0.55	(0.31, 0.98)	0.041
Is confident riding in heavy traffic w/out a bike lane	2.06	(1.22, 3.49)	0.007
Average weekly mileage in seasons you ride the most			
< 100 miles	1.00		
≥ 100 miles	2.51	(1.42, 4.46)	0.002
Always slows at uncontrolled intersections	3.61	(1.08, 12.10)	0.038
Age group†			
18-34 years	1.00		
35 years and over	1.75	(0.95, 3.22)	0.071

† Represents non-significant association included to control for potential confounding effects of age and/or years of riding exposure

Discussion

- NMVs were common in study population
- Males more likely to experience a NMV than females
  - Same is true in HDI data and other biking studies
- Age was left in the final model to:
  - Control for differences in distributions among males and females
  - Control for years of riding exposure
- Only one safety behavior associated with ever experiencing a NMV
  - May be result of a crash rather than cause

Discussion

- Those who identified themselves primarily as commuters were half as likely to crash as those who did not
  - Careful selection of familiar and safe routes?
  - Less risk-taking behavior?
  - Recreational riding more dangerous?
    - Not significantly associated with crashing in this population
- Confidence may be a proxy for other risk-taking behaviors
- Few riding exposure variables associated with NMVs
  - Seasonal variation, time of day, or riding surface not associated
- NMV within 2 years:
  - 71% reported at least one environmental factor at time of crash
  - Many may be modifiable

Limitations of Survey

- Data cannot be generalized to entire population, only BTA digest recipients
  - Low level of heterogeneity in respondent population
- Cross-sectional design makes it impossible to determine causation
- Power issues – small cell sizes
- Recall bias – validity of self-reported data
- Difficult to quantify *risk-taking behaviors*

Conclusions and Recommendations

- NMV crashes cause ¾ of bicycle hospitalizations and ¼ of bicycle mortality
  - 4th leading cause of hip fracture hospitalizations
  - 5th leading cause of TBI hospitalizations
- DOT and police report data miss the majority of the bicyclist injury burden
- NMV crashes affect <u>bicyclists of all ages</u> not just children
- Lack of associations between NMVs and behavioral risk factors
  - Suggests limited effect of behavioral safety measures and potential relevance of environmental factors in NMVs
  - Future research should focus on changes to the built environment

Thank You

Questions?

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