Original Research Article

Unhelmeted Injured Cyclists in a Canadian Emergency Department: Cycling Behavior and Attitudes Towards Helmet Use

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Abstract

Introduction: We seek to characterize unhelmeted injured cyclists presenting to the emergency department: demographics, cycling behavior, and attitudes towards cycling safety and helmet use.

Methods: This was a prospective case series in a downtown teaching hospital. Injured cyclists presenting to the emergency department were recruited for a standardized survey if not wearing a helmet at time of injury and over age 18. Exclusion criteria included inability to consent (language barrier, cognitive impairment) or admission to hospital.

Results: We surveyed 72 UICs (unhelmeted injured cyclists) with mean age of 34.3 years (range 18–68, median 30, IQR 15.8 years). Most UICs cycled daily or most days per week in non-winter months (88.9%, n = 64). Most regarded cycling in Toronto as somewhat dangerous (44.4%, n = 32) or very dangerous (5.9%, n = 4). Almost all (98.6%, n = 71) had planned to cycle when departing home that day. UICs reported rarely (11.1%, n = 8) or never (65.3%, n = 47) wearing a helmet. Reported factors discouraging helmet use included inconvenience (31.9%, n = 23) and lack of ownership (33.3%, n = 24), but few characterized helmets as unnecessary (11.1%, n = 7) or ineffective (1.4%, n = 1).

Conclusions: Unhelmeted injured cyclists were frequent commuter cyclists who generally do not regard cycling as safe yet choose not to wear helmets for reasons largely related to convenience and comfort. Initiatives to increase helmet use should address these perceived barriers, and further explore cyclist perception regarding risk of injury and death.

Keywords

bicycle, helmet, injury prevention, trauma, brain injury

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1. What Do We Already Know About this Topic?
Helmets reduce the risk of head and brain injury in cyclists involved in a collision or fall.

2. *How Does Your Research Contribute to the Field?
Despite being educated, employed, and making frequent planned trips, many cyclists choose not to wear a helmet.

3. What Are Your Research's Implications Towards Theory, Practice, or Policy?
Interventions to increase helmet use in adult cyclists should be informed by an understanding of cyclist perceptions regarding helmet convenience and comfort as well as their perspectives regarding injury risk and severity and should employ evidenced-based approaches to mitigate risk-taking behavior.

Introduction

Bicycling in Canada is widely used for transportation, recreational activity, and sport. While beneficial for individual and population health, cycling injuries are common and can result in significant morbidity or death. In 2012, the Ontario Chief Coroner's Office reported that between 2006 and 2010, there were 129 deaths among cyclists of all ages in Ontario, wherein 74% of all cyclists were not wearing a helmet at a time of the crash. Those cyclists whose cause of death included a head injury were three times more likely not to be wearing a helmet compared to those who died of other injuries.[1] The implications of brain injury can be severe for both the injured cyclist and society, potentially involving decades of lost wages and costly rehabilitation. Two strategies to mitigate the burden of traumatic brain injury (TBI) include: (1) prevention of the crash and (2) reduction of injury severity. Proven strategies to improve cycling safety have included improvements to the built environment (ie bike paths and cycle tracks), and cyclist use of other safety devices such as lights and bells.[2,3] Proven strategies to mitigate the severity of head injury and death typically incorporate bicycle helmets.[4-6] A meta-analysis by Olivier and Creighton included data from over 64 000 injured cyclists. For cyclists involved in a crash or fall, helmet use was associated with odds reductions for head injury (OR = .49, 95% confidence interval (CI): .42–.57), serious head (OR = .31, 95% CI: .25–.37), and fatal head injury (OR = .35, 95% CI: .14–.88).[4] Metanalyses by Attewell et al[5] and by Hoye et al[7] have demonstrated similar findings. Despite their proven efficacy, the use of helmets by cyclists is inconsistent where legislation making them mandatory, with enforcement, is not in effect.

Legislation mandating bicycle helmet use is common worldwide and is in effect in roughly half of OECD and EU countries (mostly commonly for children).[8] In Canada, such legislation varies by province and territory, and ranges from universal for all cyclists, to required only for those under 18, to no requirement at all. Helmet legislation appears to be effective in increasing helmet use and decreasing head injury rates in the populations for which it is implemented.[7,9-14] Recent research suggests the belief in a helmet law (even if mistaken) is an important factor for adopting helmet use.[15] Opponents of mandatory helmet use have argued that ridership will be deterred, that helmet legislation selectively deters cycling among those with low injury risk, and that wearing a helmet may lead to behavioral adaptation and more high-risk behavior.[7] A systematic review of bicycle helmet use and risk compensation found that most studies did not support risk compensation.[9,11,16]

There is a need for effective approaches to improve voluntary helmet use by adult cyclists in regions where legislation is not viewed as desirable or sufficient. The purpose of this study was to better understand the cycling practices, helmet-use patterns, and barriers to helmet use amongst non-helmeted adult cyclists presenting with a cycling injury to a downtown Toronto emergency department.

Methods

Study Design and Time Period

This was a prospective case series study in a downtown teaching hospital, from May 2016 to Sept 2019. A standardized survey was piloted for readability and language amongst five adult cyclists and refined for clarity before being finalized. Eligible patients were recruited by the treating emergency physician or nurse practitioner. The survey was administered to subjects in the ED (emergency department) by a research coordinator after providing informed consent. This study was approved by the hospital research ethics board.

Study Setting

ED of a teaching hospital in downtown Toronto.

Population

The study population comprised ED patients with cycling-related injuries, over age 18, who reported not wearing a helmet at the time of the injury. Exclusion criteria included inability to consent (language barrier, cognitive impairment) or admission to hospital.

Outcome Measures

The survey assessed basic demographics, cycling practice and history of cycling injuries, and attitudes regarding helmet use and safety.

Data Analysis

Descriptive statistics were used to summarize the data, and survey responses reported as percentages. Categorical data was analyzed using Chi square and Fisher's exact test. With some Likert scale-type questions, for analysis by gender, we combined positive response categories (ie, very often and always) and performed tests of proportions (student's t-test). All statistical analyses were performed by a University of Toronto biostatistician using SAS Version 9.4 (SAS Institute, Cary, NC, USA)

Sample Size

A convenience sample of 72 eligible ED patients consented to participate and completed the survey.

Results

Demographics

We surveyed a convenience sample of 72 Unhelmeted injured cyclists (UICs) with a mean age of 34.3 years (range 18–68, median 30 years, IQR 15.8 years). The ratio of males to females was 1:1. The majority of cyclists were in the age range of 19–29 years (45.83%). UICs were generally educated, employed or in school, and native English speakers (See Table 1).

Cycling Practice & Current Injury

All participants were riding their personal bikes at the time of injury (100.0%, n = 72), and a majority had intended to

Table 1. Demographics (n = 72).

Demographic Variable (n Respondents)		% (n)
Gender	*Male*	52.78 (38)
	Female	47.22 (34)
Age in years mean (range, median)		34.3 (18-68, 30)
Language spoken	*English*	84.72 (61)
	Other	19.4 (14)
Education (highest level)	*Primary School*	1.39 (1)
	High School	19.44 (14)
	College Diploma	18.06 (13)
	Some undergraduate	8.33 (6)
	Undergraduate degree	36.11 (26)
	Professional Degree (MD, DDS, LLB, DVM, OD)	2.78 (2)
	Graduate Degree (Masters, Doctorate)	12.50 (9)
	Prefer not to answer	1.39 (1)
	Other	
Employment status	*Student*	12.50 (9)
	Homemaker	.0 (0)
	Unemployed, seeking work	2.78 (2)
	On disability	4.17 (3)
	On parental leave	.0 (0)
	Self-employed	2.78 (2)
	Part-time employed	11.11 (8)
	Full-time employed	65.28 (47)
	Retired	1.39 (1)
What is the total yearly income for your entire household?	*Under $10, 000*	5.56 (4)
	Between $10,000-19 999	5.56 (4)
	Between $20,000 and 34 999	2.78 (2)
	Between $35,000 and 49 999	11.11 (8)
	Between $50,000 and 74 999	11.11 (8)
	Between $75,000 and 99 999	9.72 (7)
	Between $100,000 and 149 999	8.33 (6)
	Between $150,000 and 199 999	1.39 (1)
	Over $200,000	1.39 (1)
	Not sure/don't know	29.17 (21)
	Prefer not to answer	13.89 (10)
Do you live in the Greater Toronto Area (GTA)?	*Yes*	98.6 (71)

Table 2. Trip Purposes and Crash Circumstances (n = 72).

Survey Questionnaire or Response (n Respondents)		% (n)
Were you riding your personal bike?	*Yes*	100 (72)
Did you plan on cycling when you left the house?	*Yes*	98.61 (71)
	No	1.39 (1)
Did your current injury occur on a weekday?	*Yes*	90.28 (65)
	No	9.72 (7)
What were the road conditions when you set out to ride your bike?	*Dry*	76.39 (55)
	Wet	19.44 (14)
	Snow	2.78 (2)
	Other	1.39 (1)
What was the purpose of your cycling trip?	*Social/entertainment*	19.44 (14)
	Errands/personal appointments	12.50 (9)
	Restaurant/meal	.00 (0)
	Shopping	1.39 (1)
	Exercise/recreation	6.94 (5)
	Commute to or from work	50.00 (36)
	Commute to or from school	6.94 (5)
	Travel to a meeting	1.39 (1)
	Other	1.39 (1)
If so, what was the primary cause?	*Vehicle collision - car*	22.22 (16)
	Vehicle collision - bus, truck, streetcar	4.17 (3)
	Vehicle door	5.56 (4)
	Other bicycle	1.39 (1)
	Pedestrian	1.39 (1)
	Animal	.0 (0)
	Street-car or train tracks	18.06 (13)
	Other surface	.0 (0)
	*Infrastructure (*ie *curb)*	6.94 (5)
	Fall to avoid collision	4.17 (3)
	Loss of Balance	13.89 (10)
	Braking too hard	.0 (0)
	Bike Malfunction	2.78 (2)
	Item caught in wheel	1.39 (1)
	Cornering	2.78 (2)
	Fall, unclassified	19.44 (14)
What was the infrastructure like where you were injured?	*Major street, parked cars - no bike infrastructure*	52.78 (38)
	Major street, parked cars - shared lane (sharrow)	1.39 (1)
	Major street, parked cars - bike lane (painted line)	8.33 (6)
	Major street, no parked cars - no bike infrastructure	13.89 (10)
	Major street, no parked cars - shared lane (sharrow)	2.78 (2)
	Major street, no parked cars - bike lane (painted line)	5.56 (4)
	Local street - no bike infrastructure	11.11 (8)
	Local street - designated bike route	1.39 (1)
	Local street - designated bike route with traffic calming	.0 (0)
	Off - street route - cycle track with bollards	.0 (0)
	Off - street route - bike path	.0 (0)
	Off - street route - multi-use path, paved	2.78 (2)
	Off - street route - multi-use path, unpaved	.0 (0)
	Off - street route - sidewalk/pedestrian path	.0 (0)
Did you continue your trip by bicycle?	*Yes*	23.61 (17)
	No	76.39 (55)
Were you brought to the hospital by ambulance?	*Yes*	29.17 (21)
	No	70.83 (51)

cycle before leaving home (98.6%, n = 71). A majority of cyclists were unable to continue their trip by bicycle (76.4%, n = 55), but were not brought to the hospital by ambulance (70.8%, n = 51). The purpose of the cycling trip was primarily for commuting to work (50%, n = 36), social activities (19.4%, n = 14), school (6.9%, n = 5), and recreation (6.9%, n = 5) (See Table 2 for trip purposes and crash circumstances.)

Cycling Practice

Most participants owned their own bike (97.22%, n = 70). The majority of Unhelmeted cyclists rode their bikes most days per week or every day in non-winter months (88.9%, n = 64). Fewer cyclists rode their bike in winter months (44.4%, n = 32) and of those that did, a majority rode their bikes most days per week or every day in winter months (62.3%, n = 20).

Perceptions Regarding Safety, and Prior Accident Experience

Cycling in Toronto was perceived as somewhat dangerous (44.4%, n = 32) or very dangerous (5.6%, n = 4) by most. Many participants had been in a separate cycling accident in the prior 12 months (31.9%, n = 23). A small proportion of those in a prior accident presented to an ED as a result (17.4%, n = 4). (See Table 3)

Helmet Use: Practice and Impressions

Most cyclists do not wear or rarely wear a helmet while cycling (76.4%, n = 55). A majority of cyclists did not own a bike helmet (59.7%, n = 43). The three reasons most frequently cited for not wearing a helmet included not owning a helmet (33.3%, n = 24), finding helmets bulky and inconvenient (31.9%, n = 23), and finding helmets uncomfortable (27.8%, n = 20), respectively. Few cyclists responded that helmets are ineffective (1.39%, n = 1) or unnecessary (11.1%, n = 8). (See Table 4)

Analysis by Gender

Demographics

The average age was 36.5 (Median 32.5, Range 20–69) years old for males and 31.8 (Median 28.5, Range 18–64) years old for females, respectively. The major purpose of cycling in both males and females was to commute to and from work (males: 44.74%, n = 17; females: 55.9%, n = 19). Cycling behavior did not differ statistically between male and female respondents, nor did perception of cycling safety. (See Table 5)

Helmet Use: Practice and Impressions

Females were more likely to own a bike helmet than males (males: 26.3%, n = 10/38; females: 55.9%, n = 19/34) (P = .01). Females were marginally more likely to report wearing a

Table 3. Perceptions regarding safety and prior accident.

Survey Questionnaire or Response (n Respondents)		% (n)
How safe do you think cycling is in Toronto (N = 72)	*Very safe*	2.78 (2)
	Somewhat safe	18.06 (13)
	Neither safe nor dangerous	29.17 (21)
	Somewhat dangerous	44.44 (32)
	Very dangerous	5.56 (4)
Have you been in a cycling accident in the last 12 months? (N = 23)	*Yes*	31.94 (23)
If so, what was the primary cause?	*Vehicle collision - car*	30.43 (7)
	Vehicle collision - bus, truck, streetcar	.0 (0)
	Vehicle door	13.04 (3)
	Other bicycle	4.35 (1)
	Pedestrian	8.70 (2)
	Animal	.00 (0)
	Street-car or train tracks	17.39 (4)
	Other surface	4.35 (1)
	*Infrastructure (*ie *curb)*	.00 (0)
	Fall to avoid collision	4.35 (1)
	Loss of Balance	13.04 (3)
	Braking too hard	.00 (0)
	Bike Malfunction	4.35 (1)
	Item caught in wheel	.00 (0)
	Cornering	.00 (0)
	Fall, unclassified	13.04 (3)
Did you go to the emergency department because of it?	*Yes*	17.39 (4)
	No	82.61 (19)

Table 4. Helmet Use Practice and Impressions.

Survey Questionnaire or Response (n Respondents)		% (n)
Do you own a bike helmet?	*Yes*	40.28 (29)
	No	59.72 (43)
How would you describe your helmet if you have one? (n = 27)	*Fits Well*	85.19 (23)
	Is less than 5 years old	70.37 (19)
	Has sustained an impact	3.70 (1)
How often do you wear a helmet when you cycle on your own bike?	*Always*	2.78 (2)
	Most of the time	9.72 (7)
	Sometimes	11.11 (8)
	Rarely	11.11 (8)
	Never	65.28 (47)
What factors discourage you from wearing a bicycle helmet?	*I always wear my helmet*	2.78 (2)
	I sometimes forget	5.56 (4)
	Unfashionable	11.11 (8)
	Uncomfortable	27.78 (20)
	Messes my Hair	13.89 (10)
	Makes me sweaty	9.72 (7)
	Bulky or Inconvenient	31.94 (23)
	Ineffective	1.39 (1)
	Unnecessary	11.11 (8)
	Don't own one	24 (33.33)
	Don't know	4.17 (3)

Table 5. Analysis by Gender.

Survey Questionnaire or Response (n Respondents)		Male % (n = 38)	Female % (n = 34)	P-Value
Age in years mean (range)		36.5 (20–68)	31.8 (18.64)	.13
Language spoken	*English*	86.8 (33)	82.4 (28)	.60
	Other	(6)	(8)	
Education (highest level)	*University Education*	52.63 (20)	50.0 (17)	.82
	Other	47.37 (18)	50.0 (17)	
Employment status	*Part or Full Time Job*	76.32 (29)	76.47 (26)	.99
	Other	23.68 (9)	23.53 (8)	
Were you riding your personal bike?	*Yes*	97.37 (37)	97.06 (33)	
How often do you cycle in non-winter months?	*Generally Everyday*	71.05 (27)	78.79 (26)	.58
	Most Days Per Week	21.05 (8)	9.09 (3)	
	A Few Days Per Week	5.26 (2)	9.09 (3)	
	Less Than Once Per Week	2.63 (1)	.0 (0)	
	Less Than Once Per Month	.0 (0)	3.03 (1)	
Which of the following do you use?	*Bell*	68.42 (26)	73.53 (25)	.63
	Front Lights	81.58 (31)	76.47 (26)	.59
	Rear Lights	73.68 (28)	70.59 (24)	.77
Have you been in a cycling accident in the last 12 months?	*Yes*	42.11 (16)	20.59 (7)	.05
How safe do you think cycling is in Toronto	*Dangerous (Very Dangerous, Somewhat Dangerous)*	50.0 (19)	50.0 (17)	.99
	Not Dangerous (Very Safe, Somewhat Safe, Neither Safe nor Dangerous	50.0 (19)	50.0 (17)	

helmet most of the time or always when cycling on their own bike (males: 5.3%, n = 4; females: 20.6%, n = 7) (P = .07). Male and female respondents did not differ statistically when citing barriers to helmet use. The three most common reasons for not wearing a helmet (for either gender) were lack of ownership, inconvenience, and lack of comfort.

Discussion

Unhelmeted injured cyclists were frequent users of their bicycles, generally making planned trips to commute to work or school. The intentionality of riding suggests against spontaneity or forgetfulness as a principle reason for not having a

helmet on hand. Unhelmeted cyclists were typically well-educated, and few (12.5%) cited helmets as being ineffective or unnecessary as a barrier to helmet use. Cyclists were typically employed and had a household income that would presumably not make helmet cost a barrier to use. Approximately half (50%) of respondents regarded cycling in Toronto as somewhat or very dangerous, and approximately one third (31.9%) had been in a cycling accident in the prior 12 months. Nonetheless, approximately three quarters (76.4%) reported rarely or never wearing a helmet.

Education and income are associated with higher frequency of helmet use in Canada.[11,17-20] Respondents were frequent cyclists, using their bicycles to commute to work or school. This is similar to earlier studies in downtown Toronto.[19,21,22] Increased helmet use in adult commuter cyclists vs recreational cyclists has been noted in other studies.[19,23]

The primary reported reason for not wearing a helmet was inconvenience, despite an infrequent perception that helmets were unnecessary. Other studies have reported similar findings.[19,24] Non-helmet wearers do not see cycling as safe in Toronto yet made a conscious decision to not wear a helmet. In a 2016 Canada-wide survey of driving and cycling behavior, approximately, 24% of respondents reported cycling to be unsafe in the city, and 67% sometimes safe, depending on traffic levels, and more than 50% had been or knew someone in a previous accident.[25] Finnoff et al explored barriers to helmet use in the US. A majority of respondents indicated that bicycle helmets provided either "moderate" or "great" protection from head injury, although a majority of adolescents and adults indicated that there was only a "slight risk" of head injury when bicycling without a helmet.[24] Cycling risk perception has also been explored with respect to cycling frequency and route infrastructure. Frequent and more experienced cyclists are more likely to describe cycling as safe compared to less experienced cyclists, yet still see it as a dangerous mode of transportation compared to driving.[26] Cyclists vary in their safety perception and practice according to route infrastructure, but their perceptions about route safety do not align well with objective findings. In a study by Winters et al, discrepancies were observed for cycle tracks (perceived as less safe than objectively observed) and for multi-use paths shared between pedestrians and cyclists (perceived as safer than objectively observed).[27]

Informing Risk Perception

Further research should explore how cyclist perception of risk is formed, how it may influence the decision to wear a helmet, and how to tailor cyclist risk perception to improve helmet use. French et al reviewed existing systematic reviews of studies personalizing risk feedback for four key health-related behaviors (smoking, alcohol consumption, physical activity, and diet), compared to no personalized risk information. The authors reported that presenting risk information on its own, even when highly personalized, does not produce strong effects on health-related behaviors or changes which are sustained.[28] Risk provision that used visual imaging approaches to communicate risk was reported as more promising than methods involving provision of numerical risk information.[28,29] Helweg-Laresen and Sheppherd have explored *optimistic bias*—the tendency for people to report that they are less likely than others to experience negative events, and more likely than others to experience positive events. They note that people are less optimistic when comparing themselves with someone who is psychologically close or similar to them, such as a close friend or family member, than in comparison with someone who is psychologically distant or ambiguous.[29] Ferrer and Klein note the different types of risk perceptions (including deliberative (ie, quantitative, fact based), affective (emotional), and experiential (ie, "gut feeling")) and stress the role of emotion in risk perception and efforts to engage in patient behavior change.[30] The authors note the impact of personal narratives and experiences, including that of celebrities, in driving risk-reduction behavior.[30,31] Orbell et al note the role of the lack of self-regulation as a cause for motivated people to fail at behavior change, and for the need for behavior change techniques to overcome this.[32] Last, Ledesma et al report that cyclist perception of group norms is a greater predictor of helmet use than perceived benefits and risk reduction,[33] and note that this is consistent with reports that subjective norms and peer and family influence are important determinants of helmet wearing behavior.[24,33,34]

This assessment of the characteristics, cycling behaviors, and attitudes of unhelmeted cyclists presenting to an urban ED with cycling injuries adds to the body of information by examining unhelmeted cyclists in Toronto, Ontario, where helmet legislation is limited to those 18 and under.

Limitations of this study include a case series from one center. Sample size was not informed by a power calculation, and size of sample precluded subgroup analysis beyond gender. As our primary objective was to characterize unhelmeted cyclists and their barriers to helmet use, we elected not to survey helmeted cyclists as a comparison group. Potential for selection bias is introduced by exclusion criteria (patients who were unable to consent, or who were admitted to hospital). We did not quantify the use of intoxicants. Self-reported data raises potential for recall or response bias. The experience of a very recent bicycle accident may have influenced expressed relating to risk perception and attitudes towards helmets.

Conclusions

Unhelmeted injured cyclists surveyed were frequent commuter cyclists who do not regard cycling as safe yet choose not to wear helmets for reasons largely related to convenience. Initiatives to increase voluntary helmet use in this subgroup should address reasons expressed for not wearing a helmet, as well as cyclist perception of individual risk, using evidence-based principles of behavior change.

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Author Contributions

SMF is Supervising Author. He was involved in all aspects of the study including protocol design, study execution, data analysis, and manuscript preparation.
DP was involved in study execution, data analysis, and manuscript preparation.
BV is Corresponding author. She was involved in study execution, data analysis, and manuscript preparation.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethics Approval

Ethics approval was received by the University Health Network IRB. All study participants provided informed consent to participate in this study.

Availability of Data

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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References

1. Persaud N, Coleman E, Zwolakowski D, Lauwers B, Cass D. Nonuse of bicycle helmets and risk of fatal head injury: a proportional mortality, case–control study. *Cmaj*. 2012;184(17):E921-E923.
2. Letovsky E, Rowe BH, Friedman SM, Snider C, Sullivan E. Improving bicycle safety in Canada. *Can J Emerg Med*. 2015; 17(3):323-327.
3. Monsere C, Dill J, McNeil N, et al. *Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the US*; 2014.
4. Olivier J, Creighton P. Bicycle injuries and helmet use: a systematic review and meta-analysis. *Int J Epidemiol*. 2017;46(1):278-292.
5. Attewell RG, Glase K, McFadden M. Bicycle helmet efficacy: a meta-analysis. *Accid Anal Prev*. 2001;33(3):345-352.
6. Cripton PA, Dressler DM, Stuart CA, Dennison CR, Richards D. Bicycle helmets are highly effective at preventing head injury during head impact: head-form accelerations and injury criteria for helmeted and unhelmeted impacts. *Accid Anal Prev*. 2014;70:1-7.
7. Hoye A. Recommend or mandate? A systematic review and meta-analysis of the effects of mandatory bicycle helmet legislation. *Accid Anal Prev*. 2018;120:239-249.
8. Esmaeilikia M, Grzebieta R, Olivier J. A systematic review of bicycle helmet laws enacted worldwide. *Journal of the Australasian College of Road Safety*. 2018;29(3):30.
9. Macpherson A, Spinks A. Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. *Cochrane Database Syst Rev*. 2008(3).
10. Karkhaneh M, Kalenga J-C, Hagel BE, Rowe B. Effectiveness of bicycle helmet legislation to increase helmet use: a systematic review. *Inj Prev*. 2006;12(2):76-82.
11. Dennis J, Potter B, Ramsay T, Zarychanski R. The effects of provincial bicycle helmet legislation on helmet use and bicycle ridership in Canada. *Inj Prev*. 2010;16(4):219-224.
12. Dennis J, Ramsay T, Turgeon AF, Zarychanski R. Helmet legislation and admissions to hospital for cycling related head injuries in Canadian provinces and territories: interrupted time series analysis. *Bmj*. 2013;346:f2674.
13. Wesson DE, Stephens D, Lam K, Parsons D, Spence L, Parkin PC. Trends in pediatric and adult bicycling deaths before and after passage of a bicycle helmet law. *Pediatrics*. 2008;122(3): 605-610.
14. Hagel BE, Rizkallah JW, Lamy A, et al. Bicycle helmet prevalence two years after the introduction of mandatory use legislation for under 18 year olds in Alberta, Canada. *Inj Prev*. 2006;12(4):262-265.
15. Valero-Mora PM, Shinar D, Ledesma RD, et al. Abiding by the law when it does not exist: the case of the helmet bicycle law. *Transport Res F Traffic Psychol Behav*. 2020;72: 23-31.
16. Esmaeilikia M, Radun I, Grzebieta R, Olivier J. Bicycle helmets and risky behaviour: a systematic review. *Transport Res F Traffic Psychol Behav*. 2019;60:299-310.
17. Dagher JH, Costa C, Lamoureux J, De Guise E, Feyz M. Comparative outcomes of traumatic brain injury from biking accidents with or without helmet use. *Can J Neurol Sci*. 2016; 43(1):56-64.
18. Teschke K, Brubacher JR, Friedman SM, et al. Personal and trip characteristics associated with safety equipment use by injured adult bicyclists: a cross-sectional study. *BMC Public Health*. 2012;12(1):765.
19. Irvine A, Rowe BH, Sahai V. Bicycle helmet-wearing variation and associated factors in Ontario teenagers and adults. *Can J Public Health*. 2002;93(5):368-373.
20. Karkhaneh M, Rowe B, Saunders LD, Voaklander D, Hagel BE. Bicycle helmet use four years after the introduction of helmet legislation in Alberta, Canada. *Accid Anal Prev*. 2011; 43(3):788-796.
21. Teschke K, Harris MA, Reynolds CC, et al. Route infrastructure and the risk of injuries to bicyclists: a case-crossover study. *Am J Publ Health*. 2012;102(12):2336-2343.

22. Friedman SM, Adamson M, Cleiman P, et al. Helmet-wearing practices and barriers in Toronto bike-share users: a case-control study. *Can J Emerg Med*. 2016;18(1):28-36.
23. Page JL, Macpherson AK, Middaugh-Bonney T, Tator CH. Prevalence of helmet use by users of bicycles, push scooters, inline skates and skateboards in Toronto and the surrounding area in the absence of comprehensive legislation: an observational study. *Inj Prev*. 2012;18(2):94-97.
24. Finnoff JT, Laskowski ER, Altman KL, Diehl NN. Barriers to bicycle helmet use. *Pediatrics*. 2001;108(1):e4.
25. State Farm Mutual Automobile Insurance Company. *Canadian Driving Habits: 2016 Driving Survey*; 2016. https://www.multivu.com/players/English/7890451-state-farm-bike-safety/docs/infographic-state-farm-surveyed-canadians-about-cyclist-safety-551375509.pdf. Accessed June 25, 2020.
26. Lawson AR, Pakrashi V, Ghosh B, Szeto W. Perception of safety of cyclists in Dublin City. *Accid Anal Prev*. 2013;50:499-511.
27. Winters M, Babul S, Becker HJ, et al. Safe cycling: how do risk perceptions compare with observed risk? *Can J Public Health*. 2012;103(3):S42-S47.
28. French DP, Cameron E, Benton JS, Deaton C, Harvie M. Can communicating personalised disease risk promote healthy behaviour change? A systematic review of systematic reviews. *Ann Behav Med*. 2017;51(5):718-729.
29. Helweg-Larsen M, Shepperd JA. Do moderators of the optimistic bias affect personal or target risk estimates? A review of the literature. *Pers Soc Psychol Rev*. 2001;5(1):74-95.
30. Ferrer RA, Klein WM. Risk perceptions and health behavior. *Curr Opin Psychol*. 2015;5:85-89.
31. Kosenko KA, Binder AR, Hurley R. Celebrity influence and identification: a test of the Angelina effect. *J Health Commun*. 2016;21(3):318-326.
32. Orbell S, Sheeran P. 'Inclined abstainers': a problem for predicting health-related behaviour. *Br J Soc Psychol*. 1998;37(2):151-165.
33. Ledesma RD, Shinar D, Valero-Mora PM, et al. Psychosocial factors associated with helmet use by adult cyclists. *Transport Res F Traffic Psychol Behav*. 2019;65:376-388.
34. Ross LT, Ross TP, Farber S, Davidson C, Trevino M, Hawkins A. The theory of planned behavior and helmet use among college students. *Am J Health Behav*. 2011;35(5):581-590.