Letters

RESEARCH LETTER

Bicycle Trauma Injuries and Hospital Admissions in the United States, 1998-2013

Cycling is associated with many health benefits, but also with the risk of injury. Trends in bicycle-related injuries are difficult to assess because the majority of nonfatal injuries sustained while cycling are not reported to police and thus are not included in traffic statistics.[1] We sought to evaluate trends in adult cycling injuries and hospital admissions in the United States using emergency department data.

Methods | The National Electronic Injury Surveillance System (NEISS) is a national probability sample of approximately 100 emergency departments that gathers product-related injury data.[2] We queried the NEISS for injuries associated with bicycles (codes 5033 and 5040) from 1998 to 2013. The University of California, San Francisco, institutional review board gave the study exempt status.

The number of bicycle-related injuries in adults aged 18 years or older was recorded in 2-year intervals. We used the NEISS complex sample design to calculate population projections of cycling-related injuries, which were then divided by US Census data to produce incidence per 100 000 persons. Adjustment for age was performed using the direct method. Linear regression was used to evaluate trends in injuries and hospital admissions vs time (2-year intervals) for the entire sample as well as for the proportion of injuries by specific age groups. We also calculated the ratio of injuries by body part, location (street vs nonstreet), and hospital size.

Hospital size was used as a proxy for urban vs rural location given large hospitals were located in urban areas in the NEISS database. Statistical analysis was performed using R version 3.1.1 (R Project for Statistical Computing). *P* values <.05 (2-sided) were considered significant.

Results | Trends in the incidence of injuries and hospital admissions are summarized in **Table 1**. During the study period, the 2-year age-adjusted incidence of injuries increased by 28% from 96 (95% CI, 84-108) to 123 (95% CI, 110-136) per 100 000 (*P* = .02) and the 2-year age-adjusted incidence of hospital admissions increased by 120% from 5.1 (95% CI, 2.4-7.8) to 11.2 (95% CI, 7.6-14.9) per 100 000 (*P* = .001).

When evaluated by injury type, the percentage of injured cyclists with head injuries increased from 10% (95% CI, 6%-14%) to 16% (95% CI, 9%-21%) (*P* < .001) and torso injuries increased from 14% (95% CI, 10%-18%) to 17% (95% CI, 12%-22%) (*P* < .001). The percentage of injuries occurring on the street increased over time from 40% (95% CI, 18%-62%) to 56% (95% CI, 30%-82%) (*P* = .005).

Table 1. Trends in Number and Type of Bicycle Injury and in Hospital Admissions From 1998 to 2013

	1998-1999	2000-2001	2002-2003	2004-2005	2006-2007	2008-2009	2010-2011	2012-2013	% Change[a]	*P* Value[b]
No. of injury cases[c]	8791	9775	9633	10 068	11 133	13 046	14 322	15 427		
Age-adjusted incidence[d]	96 (84-108)	99 (87-110)	90 (79-101)	89 (78-99)	96 (85-108)	107 (95-119)	114 (102-126)	123 (110-136)	28	.02
No. of hospital admissions[c]	553	629	707	833	966	1239	1377	1646		
Age-adjusted incidence[d]	5.1 (2.4-7.8)	4.8 (2.4-7.3)	4.9 (2.6-7.3)	5.7 (3.2-8.1)	6.1 (3.5-8.7)	7.8 (4.9-10.8)	9.1 (6.0-12.2)	11.2 (7.6-14.9)	120	.001
Type of injury, % (95% CI)										
Head	10 (6-14)	10 (5-14)	10 (6-15)	12 (7-16)	12 (7-16)	14 (9-19)	15 (10-19)	16 (9-21)	60	<.001
Torso	14 (10-18)	14 (10-18)	14 (10-18)	15 (11-19)	16 (11-20)	16 (12-20)	17 (12-22)	17 (12-22)	20	<.001
Extremity	59 (46-72)	60 (45-74)	59 (43-71)	57 (41-70)	56 (41-70)	55 (41-70)	53 (40-67)	52 (37-66)	−12	<.001
Other body part	17 (11-23)	17 (12-22)	17 (11-22)	16 (11-22)	15 (11-22)	15 (11-21)	15 (10-20)	16 (10-20)	−9	.004
Location (street), % (95% CI)	40 (18-62)	43 (23-63)	49 (30-67)	55 (33-77)	53 (30-76)	52 (31-74)	54 (32-75)	56 (30-82)	40	.005
Large hospital, % (95% CI)[e]	53 (35-71)	51 (29-73)	50 (31-69)	51 (31-72)	49 (27-70)	50 (31-69)	53 (34-73)	57 (32-82)	8	.31

[a] Indicates change from 1998-1999 to 2012-2013; calculated as: [(value for 2012-2013 − value for 1998/1999)/(value for 1998-1999)] × 100.

[b] Calculated using linear regression for each parameter compared with period in 2-year increments (eg, injuries vs time).

[c] Counts from the National Electronic Injury Surveillance System (NEISS) database for adults aged 18 years or older in 2-year intervals.

[d] Adjustment for age performed using the direct method. Incidence expressed as a population estimate of injured cyclists per 100 000 persons in the US population (95% CI).

[e] Defined as hospitals in the large or very large strata in the NEISS database.

Table 2. Proportion of Bicycle Injuries and Hospital Admissions by Age Group From 1998 to 2013

Age Group, y	% (95% CI)								%	P
	1998-1999	2000-2001	2002-2003	2004-2005	2006-2007	2008-2009	2010-2011	2012-2013	Change[a]	Value[b]
18-24										
Injuries	25 (24-26)	24 (23-25)	22 (21-23)	23 (22-24)	22 (21-24)	23 (22-24)	23 (22-24)	22 (21-22)	−12	.02
Hospital admissions	12 (9-16)	14 (10-18)	10 (7-12)	8 (6-11)	12 (9-15)	11 (9-13)	9 (7-11)	12 (10-14)	0	.52
25-34										
Injuries	28 (27-29)	25 (24-26)	23 (22-25)	21 (20-22)	20 (19-21)	20 (19-21)	20 (20-21)	20 (19-21)	−27	.004
Hospital admissions	20 (15-25)	16 (13-20)	17 (13-21)	17 (14-21)	14 (11-16)	12 (9-14)	14 (11-16)	12 (10-14)	−41	.004
35-44										
Injuries	25 (23-26)	24 (23-25)	25 (24-26)	23 (22-24)	21 (20-23)	20 (19-21)	18 (17-18)	17 (16-18)	−32	<.001
Hospital admissions	29 (23-35)	27 (22-32)	19 (15-23)	16 (13-19)	15 (12-18)	14 (12-17)	12 (11-16)	12 (10-14)	−60	.001
45-54										
Injuries	12 (11-13)	15 (14-15)	17 (16-18)	19 (18-20)	20 (19-21)	21 (20-22)	20 (20-21)	21 (20-22)	77	.001
Hospital admissions	13 (9-16)	20 (15-25)	23 (19-28)	32 (27-38)	25 (21-30)	23 (19-27)	28 (24-32)	25 (22-28)	96	.12
55-64										
Injuries	6 (5-7)	8 (7-8)	8 (7-9)	8 (7-9)	10 (9-11)	11 (10-12)	12 (11-13)	14 (13-15)	130	<.001
Hospital admissions	13 (9-17)	12 (8-16)	13 (10-17)	12 (9-15)	20 (16-24)	22 (18-26)	19 (16-22)	23 (20-26)	78	.005
65-74										
Injuries	4.2 (3.7-4.8)	3.8 (3.4-4.3)	3.9 (3.4-4.4)	4.9 (4.3-5.4)	5.0 (4.4-5.5)	5.0 (4.5-5.5)	5.5 (5.0-6.0)	5.5 (5.0-6.0)	30	.002
Hospital admissions	5.9 (3.3-8.6)	5.7 (3.2-8.3)	8.0 (5.1-11.0)	6.6 (4.4-8.8)	9.0 (5.8-11.0)	10.4 (7.7-13.0)	12.4 (9.9-15.0)	9.2 (7.2-11.0)	56	.01
≥75										
Injuries	0.9 (0.4-1.3)	0.9 (0.4-1.3)	1.2 (0.7-1.7)	1.0 (0.6-1.5)	1.4 (0.9-1.9)	1.4 (1.0-1.9)	1.3 (0.9-1.7)	1.3 (0.9-1.7)	50	.02
Hospital admissions	7.2 (3.8-11.0)	5.1 (2.3-7.9)	9.7 (6.0-13.0)	7.7 (4.4-11.0)	6.0 (3.4-8.7)	8.3 (5.3-11.0)	6.0 (3.8-8.1)	7.6 (5.3-9.8)	6	.94

[a] Indicates change from 1998-1999 to 2012-2013; calculated as: [(value for 2012-2013 − value for 1998/1999)/(value for 1998-1999)] × 100.

[b] Determined using linear regression (percentage vs period in 2-year increments).

There was no significant change in the proportion of injured patients presenting to large hospitals. Overall, 35% of injuries occurred in women and there was no significant change in sex ratio over time.

Changes in the proportion of injuries occurring within specific age groups are summarized in **Table 2**. The proportion of injuries occurring in individuals older than 45 years increased 81% from 23% (95% CI, 20%-26%) to 42% (95% CI, 39%-45%) ($P < .001$) and the proportion of hospital admissions in individuals older than 45 years increased 66% from 39% (95% CI, 25%-53%) to 65% (95% CI, 55%-75%) ($P < .001$).

Discussion | This study reports an increase in bicycle-related injuries and hospital admissions in adults in the United States between 1998 and 2013. The increase in overall injuries was driven by an increase in injuries in individuals older than 45 years. The increase in hospital admissions outpaced the increase in overall injuries, perhaps due to an increase in severe injuries in older individuals,[3] who made up a greater proportion of injured cyclists in 2012-2013 compared with 1998-1999. These injury trends likely reflect the trends in overall bicycle ridership in the United States in which multiple sources show an increase in ridership in adults older than 45 years.[4,5]

Other possible factors contributing to the increase in overall injuries and hospital admissions include an increase in street accidents[4] and an increase in sport cycling associated with faster speeds.[6] As the population of cyclists in the United States shifts to an older demographic, further investments in infrastructure and promotion of safe riding practices are needed to protect bicyclists from injury.

Limitations include the use of a public health surveillance database that lacks granular data on specific causes of injury, use of protective equipment (eg, helmets), and specific diagnoses (*International Classification of Diseases* codes).

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Obtained funding: Breyer.
Administrative, technical, or material support: Callcut, Carroll, Breyer.
Study supervision: Breyer.

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Breyer reported serving on an advisory board for American Medical Systems. No other disclosures were reported.

Funding/Support: Dr Breyer is supported by grant K12DK083021 from the National Institute of Diabetes and Digestive and Kidney Diseases. Dr Callcut is supported by grant 8KL2TR000143-09 from the National Institutes of Health.

Role of the Funder/Sponsor: The National Institute of Diabetes and Digestive and Kidney Diseases and the National Institutes of Health had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Additional Contributions: We thank Thomas Schroeder, MS, from the National Electronic Injury Surveillance System (NEISS) for his assistance with the current NEISS sample; no compensation was received.

1. Lopez DS, Sunjaya DB, Chan S, Dobbins S, Dicker RA. Using trauma center data to identify missed bicycle injuries and their associated costs. *J Trauma Acute Care Surg*. 2012;73(6):1602-1606.

2. Division of Hazard and Injury Data Systems, US Consumer Product Safety Commission. The National Electronic Injury Surveillance System. http://www.cpsc.gov//PageFiles/106626/2000d015.pdf. Accessed January 23, 2015.

3. Rivara FP, Thompson DC, Thompson RS. Epidemiology of bicycle injuries and risk factors for serious injury. *Inj Prev*. 1997;3(2):110-114.

4. Pucher J, Buehler R, Seinen M. Bicycling renaissance in North America? an update and re-appraisal of cycling trends and policies. *Transp Res Part A Policy Pract*. 2011;45(6):451-475.

5. Edmonson B. The US bicycle market: a trend overview. http://www.gluskintownleygroup.com/downloads/The%20US%20Bicycle%20Market%20-%20A%20Trend%20Overview%20Report.pdf. Accessed June 30, 2015.

6. USA Cycling and the USA Cycling Development Foundation. 2013 Annual report. https://s3.amazonaws.com/USACWeb/forms/media/2013-USA-Cycling-Annual-Report.pdf. Accessed April 11, 2015.

COMMENT & RESPONSE

Assessing Eligibility for Anticoagulation After Diagnosis of Atrial Fibrillation

To the Editor Some points in the review by Drs Lip and Lane[1] about stroke prevention in atrial fibrillation deserve further discussion.

We disagree with the suggestion of using the score for sex, age, medical history, treatment, tobacco, and race ($SAMe\text{-}TT_2R_2$) as a tool for assessing patients' eligibility for treatment with a non-vitamin K antagonist oral anticoagulant (NOAC). Use of the $SAMe\text{-}TT_2R_2$ score in everyday clinical practice would require great caution and further evaluation, especially considering that it has been validated as a tool for predicting poor international normalized ratio (INR) control rather than the effect of anticoagulation strategies on clinical outcomes in real-world practice.[2]

We agree with the guideline from the National Institute for Health and Care Excellence on the management of atrial fibrillation[3] that suggests such validation would require a randomized trial of patients in whom poor anticoagulant control is predicted (using the $SAMe\text{-}TT_2R_2$ score), who would receive either warfarin or a NOAC, to assess efficacy on hard end points, such as stroke and other thromboembolic complications, major hemorrhage, and death. A pragmatic design mimicking real-world practice conditions would be preferable because the degree of benefit with warfarin depends on the time in therapeutic range (TTR). If the TTR is low due to low patient adherence, it is uncertain whether adherence (and outcomes) would improve with a NOAC.

We agree with the authors that stroke prevention is a compelling priority for patients with atrial fibrillation and that aspirin does not offer adequate protection to patients carrying a substantial risk of stroke, as confirmed by a recent clinical trial.[4] However, in the absence of properly designed trials, choice of anticoagulant drug should rely on clinical grounds and on inclusion and exclusion criteria in trials.

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Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none were reported.

1. Lip GY, Lane DA. Stroke prevention in atrial fibrillation: a systematic review. *JAMA*. 2015;313(19):1950-1962.

2. Apostolakis S, Sullivan RM, Olshansky B, Lip GYH. Factors affecting quality of anticoagulation control among patients with atrial fibrillation on warfarin: the $SAMe\text{-}TT_2R_2$ score. *Chest*. 2013;144(5):1555-1563.

3. National Institute for Health and Care Excellence. Atrial fibrillation: the management of atrial fibrillation. http://www.nice.org.uk/guidance/cg180/evidence/cg180-atrial-fibrillation-update-full-guideline3. Accessed on July 14, 2015.

4. Palareti G, Salomone L, Cavazza M, et al. Stroke/thromboembolism and intracranial hemorrhage in a real-world atrial fibrillation population: the Complications of Atrial Fibrillation in the Bologna Area (CAFBO) study. *Chest*. 2014;146(4):1073-1080.

In Reply Many of the clinical risk scores currently used in everyday practice have not been formally tested in prospective randomized clinical trials. Variability in INRs and TTR is dependent on many clinical risk factors,[1] and the $SAMe\text{-}TT_2R_2$ score simply puts the more common clinical factors into a simple acronym for easy use in everyday clinical practice[2] rather than relying on guesswork.

The TTR can also be influenced by many other factors (eg, genotype) that are not included in the $SAMe\text{-}TT_2R_2$ score, but these are not easily measured or quickly quantified. The development of the $SAMe\text{-}TT_2R_2$ score was driven by the need for a simple and practical score based on clinical factors that can be easily used in busy clinics and wards.

The $SAMe\text{-}TT_2R_2$ score has been validated in various independent cohorts of patients with atrial fibrillation.[3] These studies consistently show that the score can identify (C-index ≥0.7)[2] those patients likely to do well while taking a VKA (eg, warfarin) with good quality anticoagulation control (as reflected by a high