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Reporting of Concussion-Like Symptoms After Cycling Crashes: A Survey of Competitive and Recreational Cyclists

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Context: Cycling crashes are common among recreational and competitive riders and may result in head and bodily trauma. Information is limited regarding the signs and symptoms of head injury (HI) after cycling crashes, medical treatment, and recovery.

Objectives: To evaluate concussion-like symptom reporting after cycling crashes with or without HI in recreational and competitive cyclists and to assess crash characteristics and follow-up medical care.

Design: Cross-sectional study.

Setting: Voluntary online survey.

Patients or Other Participants: A convenience sample of 780 cyclists residing in the United States: 528 males, 249 females, 2 gender queer/nonbinary, and 1 transgender female.

Main Outcome Measure(s): Survey-based, self-reported signs and symptoms of HI, including the third edition of the Sport Concussion Assessment Tool (SCAT3) symptom checklist, loss of consciousness, posttraumatic amnesia, and helmet damage.

Results: Of the participants, 403 reported crashes in the previous 2 years. Cyclists who self-reported *no significant injury* after their crash were excluded, leaving 77 HI reporters (HI group) and 260 trauma controls (TC group). The HI group more frequently reported experiencing 17 of the 22 symptoms on the SCAT3 symptom checklist. The HI group described a 4-fold higher incidence of loss of consciousness (HI = 13/77 [16.9%] versus TC = 11/2600 [4.2%]) and memory loss immediately after the crash (HI = 44/77 [57.1%] versus TC = 37/260 [14.2%]). The HI group reported major, noncosmetic helmet damage 2.5 times more frequently than the TC group (HI = 49/77 [63.6%] versus TC = 67/260 [25.8%]).

Conclusions: The findings suggest that a standardized concussion assessment is needed for cyclists who experience major trauma.

Key Words: epidemiology, traumatic brain injuries, head injuries, bicycling

Key Points

- Cycling crashes resulting in head injury (HI) are common, and literature on this topic is limited.
- Reporting of HIs in cyclists is a challenge due to the diversity of types of cycling, demographics, experiences, and skill levels.
- A concussion-assessment tool is needed for the sport of cycling, as HIs in cyclists may be underreported and undertreated.
- Cyclists experiencing head trauma are more likely to endorse a higher number of concussion symptoms, as well as signs of potential HI (helmet damage, loss of consciousness, posttraumatic amnesia), than those who experienced non-head trauma.
- Both HIs and other bodily injuries from cycling crashes can cause symptoms including several sleep-related and emotional symptoms, similar to posttraumatic stress symptoms.
- Most cyclists who reported HIs returned to cycling at their previous level.

Cycling has experienced massive growth in recent years, and with a rising number of recreational and commuter cyclists comes a potential increase in injuries.[1] Recent researchers[2] addressed the prevalence of head injury (HI) among 3854 injured cyclists seeking emergency care in Seattle in 2015. They found that 35% were diagnosed with facial injuries; 22.3% were diagnosed with scalp, skull, forehead, or mild brain injuries; and 6% were diagnosed with more serious brain injuries. Similarly, according to the National Electronic Injury Surveillance System All Injury Program database from 2001 to 2012, a recreational or sport-related traumatic brain injury (TBI) from cycling was the most common cause in females and the second most common cause in males presenting to an emergency department.[3]

In response, multiple, widespread efforts have been implemented to reduce HIs and all-cause injuries in cycling. Investigators[2,4] who assessed the use of cycling helmets estimated that a hard helmet resulted in a 50% odds reduction of the risk of HI and was associated with up to a 90% reduction in the risk of death due to cycling. Improvements in infrastructure have also reduced the number of crashes and injuries among cyclists.[5] These data notwithstanding, HIs still accounted for a significant portion of total cycling injuries and even deaths for cyclists who wore helmets.[2,6] Head injuries can have tremendous effects on long-term function and quality of life.[7–9]

Cyclists are a diverse group, including competitive, noncompetitive, recreational, and commuter athletes, with wide ranges of ages and skill levels.[10] For this reason, information regarding HIs in cycling is limited. The National Electronic Injury Surveillance System All Injury Program uses emergency department records to document HI rates but does not account for cyclists who do not present to the hospital and does not describe demographic groups or levels of participation in a given activity (competitive versus recreational). The National Collegiate Athletic Association Injury Surveillance Program (NCAA-ISP) follows collegiate athletes but lacks information about recreational athletes.[11] In addition, the NCAA-ISP data are less applicable to the broad demographic profile (age and athleticism) of the sport of cycling.[11] In competitive cycling, competitions may occur outside the purview of governing sports organizations, making injury monitoring difficult. Equally challenging is the lack of consensus regarding a standardized concussion assessment for both amateur and professional competitors. Thus, cycling is not subject to formal and standardized HI surveillance, and our knowledge of concussion and its presentation and recovery after cycling crashes remains limited.

In this survey-based study, we sought to characterize injuries and describe symptom profiles in a broad group of competitive and noncompetitive cyclists. In addition, we compared symptom reporting and related factors between cyclists who crashed and did or did not sustain HIs. We also assessed whether an instrument such as the third edition of the Sport Concussion Assessment Tool (SCAT3) Symptom Evaluation, a symptom checklist embedded in the SCAT3, would be a valuable clinical tool after cycling-related trauma.

METHODS

We obtained survey data from a voluntary online assessment that was conducted using REDCap software (Vanderbilt University, Nashville, TN),[12] deemed exempt by the institutional review board, and hosted by Partners Healthcare (#2014P002211/SRH). The survey, entitled "Injury Issues in the Cycling Community," was estimated to take 5 to 10 minutes to complete. Responses were recorded only if they were 100% complete and verified. The online survey was openly distributed to the cycling community via e-mail, social media, and a cycling health-related Web site. Participants were encouraged to share the survey with their club or team as well as their contacts. The survey was administered from January 24, 2015, through May 3, 2016, and 780 people (528 male, 249 female, 2 gender queer/nonbinary, and 1 transgender female) residing in the United States responded.

Of the participants, 403 reported at least 1 crash in the previous 2 years. Cyclists who experienced more than 1 crash were instructed to respond based on the most severe crash. The survey assessed the primary area of injury (upper body, lower body, skin only, head, spine, other, or none). From the SCAT3 Symptom Evaluation, 22 questions assessed the presence of neurologic symptoms after the crash, including posttraumatic amnesia, loss of consciousness, and concussion-like symptoms.[13] It should be noted that the components of the Symptom Evaluation have not changed between the SCAT3 and the current fifth edition.[13,14] The fifth edition of the Sport Concussion Assessment Tool (SCAT5) is used broadly in sports to help diagnose concussion and serves as a reporting mechanism for the NCAA-ISP.[14] Crash characteristics, including the presence of major, noncosmetic damage to the helmet or bike resulting from the crash, were assessed. Finally, the survey asked if the cyclist returned to cycling at his or her previous level and about the time he or she returned to sport.

Focusing on the 403 participants who reported a crash in the previous 2 years, we assessed differences in the survey responses of cyclists who crashed and reported a significant HI (HI group: $n = 77$; 41 males, 34 females, 2 nonbinary or transgender) versus a group of cyclists who crashed and reported a significant injury to another part of the body but not to the head (trauma control [TC] group: $n = 260$; 190 males, 70 females). The 66 cyclists (49 males, 17 females) who specified that they sustained no significant injury were excluded from both groups. Therefore, the HI and TC groups in this study were self-selected based on their own injury reporting. We did not verify the information reported by participants.

For statistical analysis of survey response data, we calculated a 2-tailed t test, P values, and confidence intervals to evaluate whether differences in respondents' answers to yes/no survey questions were statistically significant because the number of participants was large in all cases. To evaluate differences in responses regarding the number of years of cycling experience and miles per week, a nonparametric Mann-Whitney U test was used, as the survey grouped these data into ordinal but nonparametric categories. All statistical analyses were performed using Excel (version 2013; Microsoft Corp, Redmond, WA).

RESULTS

Demographics and Medical History of Survey Respondents

The 780 survey respondents resided in 32 states. States with 10 or more respondents were Massachusetts (472), Connecticut (79), Illinois (72), New York (29), California (29), Pennsylvania (23), and New Hampshire (10). Demographic data are summarized in Table 1. The data suggest that a majority of survey respondents were avid cyclists. The median number of years cycling was 10 to 20, and the median mileage was 101 to 125 miles/week for males and 51 to 75 miles/week for females. Approximately half of the survey respondents, both male and female, participated in some form of bicycle racing (51.7% of

Table 1. Demographics of Survey Respondents

Variable	All Cyclists	Head Injury Group	Trauma Control Group	Significance, *P* Value
Total respondents (n)	780	77	260	<.01
Age (mean ± SD)	43.8 ± 13.8	38.0 ± 13.8	42.1 ± 13.8	[a]
Minimum	18	18	18	
Maximum	84	74	84	
Median no. of years cycling	10–20	5–10	10–20	[a]
Median no. of miles/week				
Warm months (April–September)	101–125	101–125	126–150	[a]
Cold months (October–March)	51–75	51–75	51–75	[a]
Racing experience, No./total (%)	398/780 (51.0)	54/77 (70.1)	169/260 (65.0)	.51
Regular helmet use, No./total (%)	765/780 (98.1)	76/77 (98.7)	257/260 (98.8)	.98

[a] Male versus female respondents and head injury versus trauma control group responses were not different based on Mann-Whitney *U* tests ($\alpha = .05$).

males, 49.4% of females). Nearly all respondents (765/780, 98.1%) regularly used helmets while cycling.

The HI group had a roughly 4-fold higher incidence than the TC group of both loss of consciousness and memory loss immediately after the crash (Table 2).

Medical history was assessed using a checklist of items, including musculoskeletal, medical, and psychiatric disorders. No differences were evident between the HI and TC groups in any medical history items.

Assessment of Cycling Crashes and Related Injuries

About 30% of crashes occurred during races, 45% during training rides, and 25% while commuting. Crashes were most frequently caused by collisions with motor vehicles and other riders. Neither the circumstances of the crash (race, training, or commuting) nor the mechanism of the crash (collision with motor vehicle, another rider, or pedestrian; rider error; unforeseen obstacle; change in road surface; mechanical failure; or multitasking) showed any difference between the HI and TC groups. Regarding markers of crash severity, HI cyclists were 2.5 times more likely to incur major, noncosmetic damage to their helmet (49/77, or 63.6% of the HI group versus 67/260, or 25.8% of the TC group; $P < .01$).

The HI group was more likely than the TC group to have experienced concussion symptoms. The groups differed in all SCAT3 symptoms they recalled having except for trouble falling asleep and being more emotional, more irritable, sadder, and more anxious after the crash (Tables 3 and 4). The average number of concussion symptoms in the HI group was 5.8, whereas the TC group had an average of 0.9 symptoms ($P < .01$). Of the cyclists in the HI group, 10/77 (13.0%) had no concussion symptoms, compared with 157/260 (60.4%) of the TC group ($P < .01$).

Medical Care for Reported Head Injuries and Return to Activity

Of the 77 cyclists in the HI group, 49 (63.6%) received medical care, 44 of whom received emergency care. This included all 13 HI group cyclists who experienced loss of consciousness; 2 saw a neurologist. Of the 44 cyclists in the HI group who endorsed posttraumatic amnesia, 35 received medical care, 30 in the emergency department and 5 from a neurologist. The remaining 28 cyclists in the HI group (36.3%) received no medical care after their crash; of these, 5 cyclists were injured during competition. Nine of the 44 HI group cyclists who reported posttraumatic amnesia (including 1 in competition) did not receive any medical care (20.4%).

The vast majority of the 77 cyclists in the HI group returned to cycling at their previous level (71/77, or 92.2%; 39/41 male cyclists and 30/34 of female cyclists). The survey assessed the timeframe for return to cycling at the precrash level with choices ranging from less than 1 week to more than 24 weeks (6 months) in 1-week increments. Fewer cyclists with HIs returned to cycling immediately: 19/77 (24.7%) of the HI group returned within 1 week versus 104/260 (40%) of the TC group ($P < .02$). More cyclists with HIs waited 4 weeks to return: 16/77 (20.7%) of the HI group versus 20/260 (7.7%) of the TC group ($P < .01$). Overall, the majority of cyclists returned to cycling at their precrash level within 6 weeks: 55/77 (71.4%) of the HI group, and 191/260 (73.5%) of the TC group.

DISCUSSION

In this survey-based study of 780 recreational and competitive cyclists, we assessed injuries related to crashes and evaluated the reports of common HI signs and symptoms outlined in the SCAT3, comparing the presence of concussion symptoms between cyclists who sustained

Table 2. Initial Evidence of Traumatic Injury to the Head

Evidence	Group, No. (%)			*P* Value (Head Injury Versus Trauma Control Group)
	All Cyclists (n = 403)	Head Injury (n = 77)	Trauma Control, (n = 260)	
Major damage to helmet	123 (30.5)	49 (63.6)	67 (25.8)	<.01
Loss of consciousness	24 (6.0)	13 (16.8)	11 (4.2)	<.01
Posttraumatic amnesia	87 (21.5)	44 (57.1)	37 (14.2)	<.01
2 Symptoms	34 (8.4)	22 (28.6)	12 (4.6)	<.01
All 3 symptoms	21 (5.2)	11 (14.3)	10 (3.8)	<.01

Table 3. **Concussion-Symptom Reporting From Cycling Crashes With Significant Injuries: SCAT3 Symptom Evaluation Symptoms 1 Through 11**

Symptom	Group, No. (%)			*P* Value (Head Injury Versus Trauma Control Group)
	All Cyclists (n = 403)	Head Injury (n = 77)	Trauma Control (n = 260)	
Headache	75 (25)	54 (70)	18 (6.9)	<.01
Pressure in head	19 (4.7)	16 (21)	2 (0.8)	<.01
Neck pain	67 (16.6)	31 (40)	31 (12)	<.01
Nausea or vomiting	19 (4.7)	13 (17)	5 (2.0)	<.01
Dizziness	42 (10.4)	26 (34)	12 (4.6)	<.01
Blurred vision	19 (4.7)	15 (19)	3 (1.2)	<.01
Balance problems	19 (4.7)	16 (21)	3 (1.2)	<.01
Sensitivity to light	17 (4.2)	16 (21)	1 (0.3)	<.01
Sensitivity to noise	16 (4)	14 (18)	1 (0.3)	<.01
Feeling slowed down	30 (7)	23 (30)	6 (2.3)	<.01
Feeling like in a fog	43 (10.6)	30 (39)	10 (3.8)	<.01

Abbreviation: SCAT3, Sport Concussion Assessment Tool, third edition.

HIs and those who had injuries that did not involve the head (TCs). In addition to endorsing a higher number of postconcussive symptoms, cyclists with HIs were more likely to indicate major damage to the helmet, loss of consciousness, and posttraumatic amnesia. Cyclists with HIs also took longer to return to biking than the TC group. Finally, both the HI and TC groups had similar emotional symptoms on the SCAT3, suggesting that emotional distress was common after cycling crashes.

The HI group experienced more postconcussive symptoms than the TC group. The average number of SCAT3 symptoms endorsed has been estimated between 1.75 and 3.2 for the general population.[15–17] By comparison, the number of these symptoms endorsed by youth athletes who sustained HIs was 9.7.[16] Consistent with these studies, our data revealed a higher number of postconcussive symptoms endorsed by cyclists who reported HIs versus those who did not. Cyclists in the TC group indicated, on average, 1 or no postconcussive symptoms, whereas cyclists with HI indicated an average of 5.75 symptoms; the SCAT is the most well-established screening tool across sports, and the SCAT symptoms checklist is likely a valuable screening tool in this population.[18]

When we compared symptoms in the HI and TC groups at the item level, cyclists in the HI group more frequently had 17 of the 22 postconcussive symptoms than those in the TC group. However, the HI and TC cyclists had equal trouble falling asleep as well as several emotional symptoms (being more emotional, irritable, sad, and anxious). Interestingly, these symptoms overlap with symptoms of posttraumatic stress, which may be experienced by any cyclist who has sustained an injury. Recent researchers[19] compared groups of collegiate athletes with concussions and healthy athletes using preinjury and postinjury questionnaires and found that the former reported a greater incidence of posttraumatic stress symptoms, which increased from baseline to the postinjury measurement. In managing athletes after HI and non–head injury, it is important to remember that emotional trauma is not uncommon, as shown in the concussion literature[8] and in a recent study[20] of young athletes who sustained an anterior cruciate ligament rupture. Screening tools for behavioral health-related changes may warrant implementation among those with long-term symptoms after a cycling crash.

Cyclists in the HI group were 2.5 times more likely to sustain major, noncosmetic damage to the helmets than cyclists in the TC group, presumably a reflection of the impact to the head sustained during the crash. This result corroborates findings of a previous large-scale study[21] showing a strong correlation between helmet damage and HI among 527 helmeted cyclists who crashed. Biomechanical research[22] has shown that bicycle helmets reduce the acceleration of impact with the head by about 80%, thereby reducing the risk of

Table 4. **Concussion-Symptom Reporting From Cycling Crashes With Significant Injuries, SCAT3 Symptom Evaluation Symptoms 12 Through 22**

Symptom	Group, No. (%)			*P* Value (Head Injury Versus Trauma Control)
	All Cyclists (n = 403)	Head Injury (n = 77)	Trauma Control (n = 260)	
Don't feel right	48 (12)	32 (42)	13 (5)	<.01
Difficulty concentrating	29 (7.1)	25 (32)	3 (1.2)	<.01
Difficulty remembering	22 (5.4)	19 (25)	3 (1.2)	<.01
Fatigue or low energy	30 (7)	18 (23)	11 (4.2)	<.01
Confusion	21 (5.2)	15 (19)	4 (1.5)	<.01
Drowsiness	19 (4.7)	16 (21)	3 (1.2)	<.01
Trouble falling asleep	12 (2.9)	5 (6.5)	6 (2.3)	.07
More emotional	37 (9)	9 (12)	22 (8.5)	.39
Irritability	30 (7)	10 (13)	19 (7.3)	.12
Sadness	21 (5.2)	4 (5.2)	15 (5.8)	.85
Nervous or anxious	39 (9.6)	8 (10)	24 (9.2)	.76
None of these	211 (52)	10 (13)	157 (60)	<.01
Mean no. of symptoms	1.8	5.8	0.9	<.01

Abbreviation: SCAT3, Sport Concussion Assessment Tool, third edition.

severe HI at a speed of 12 to 15 miles/hour. However, at higher speeds, the risk of HI is substantial, even among helmeted cyclists, and the integrity of the helmet may be compromised in those who crash. Additionally, helmets are less effective at preventing mild TBI or concussion. These data suggest that if the impact force from a cycling crash is sufficient to cause major damage to a cycling helmet, the possibility of a TBI must be considered. One notable feature of the self-defined TC group in this study was that 4.6% of TC respondents had at least 2 of the 3 signs of an unequivocal TBI (loss of consciousness, posttraumatic amnesia, helmet damage), and 3.8% had all 3 symptoms, yet they answered *no* when asked whether they had sustained an injury to the head. These responses suggest that HIs may be underreported even among our survey respondents, and some of those in the TC group may in fact have sustained an HI. In this case, differences between the HI and TC groups in terms of symptom reporting may in fact be larger than what we have demonstrated.

Most of the HI group received some type of medical care, typically delivered by emergency services either on-site or in an emergency department. However, a significant minority of cyclists in our study with an HI did not receive medical treatment, including several cyclists with posttraumatic amnesia, 1 of whom was injured during competition. This is unfortunately not uncommon, as evidenced by recent longitudinal investigations[23,24] showing gaps in follow-up care for individuals with mild TBI, even those with persistent symptoms. The SCAT3 on-field assessment stipulates that athletes who experience loss of consciousness or loss of memory at the time of injury should be removed from play and evaluated by a medical professional.[13] Clinicians and cyclists must not only understand the acute management of HI but also identify often vague or nonspecific symptoms and appropriate long-term follow-up, including multidisciplinary care.[24]

The HI group in our study had a slower return to the previous level of cycling than the TC group: more cyclists in the TC group returned within 1 week, whereas more cyclists in the HI group waited 4 weeks to return to sport. In the HI group, 24% returned within 1 week, 56% returned within 2 weeks, and 92.3% returned within 4 weeks. Return-to-sport timeframes of 6 to 10 days were documented after concussions in NCAA athletes.[11] However, data on the timeframe of return to sport after cycling injuries are lacking. Although the cyclists in our HI group took longer to return to cycling than NCAA athletes with head injuries, direct comparisons are not possible as NCAA athletes are subject to baseline and postinjury comparison testing by medical staff, whereas many cyclists lack medical oversight or baseline testing.

Future efforts to care for competitive cyclists might include preseason or annual SCAT5 testing, which is required for many athletes and is useful for determining symptom resolution and informing return-to-activity timelines.[13] This baseline testing, along with appropriate guidelines to athletes and medical staff and a postinjury SCAT5 assessment, could help to determine when an injured cyclist is ready to return to activity.[25] This suggestion aligns with the "Concussions in Cycling Consensus Statement" of the Medicine of Cycling Conference,[26] which recommended the use of SCAT testing (at that time, SCAT2) for baseline and postinjury assessments and to help diagnose concussions among cyclists participating in sanctioned competitions. Newer technologies are also emerging, including cell phone–based evaluation tools, which may assist in concussion diagnosis. However, at this time, concussion remains a clinical diagnosis with no single diagnostic tool.

Competitive bike racing poses a significant challenge to team physicians and medical staff due to the fast pace and limited time and resources available for evaluation and potential clearance of cyclists to return to the race. In addition, injuries are often sustained at high speeds, and catastrophic injuries, including intracranial hemorrhage, are therefore ranked higher on the differential diagnosis. The "Concussions in Cycling Consensus Statement"[26] includes the recommendation that cyclists with signs or symptoms of a concussion be withdrawn from competition; a cycling-specific concussion-evaluation card is available for download to assist with assessments. Union Cycliste Internationale, the governing body of international professional cycling competition, recommended the use of the SCAT3 and later versions,[27] but at this time, in spite of recommendations from cycling medicine experts,[28] no formal oversight of most amateur cyclists occurs and no standardized brain injury-assessment tool has been identified. Outside of the highest levels of professional cycling (Union Cycliste Internationale WorldTeams and Professional Continental teams), elite cycling teams typically do not have a team doctor or medical staff available to evaluate injuries or perform sideline concussion assessments. Given the current state of HI monitoring in cycling, in light of the results of our study and others, more efforts are needed regarding concussion assessment and treatment in recreational and amateur cyclists.

LIMITATIONS

This study had several clear limitations. Our respondents represented a subset of the cycling community, and our findings may not apply to all cyclists in the United States, based on differences in location, helmet use,[29] sex,[30] and participation in racing. Symptom reporting in this type of assessment is subject to recall bias and overreporting or underreporting of symptoms.[31] It is important to note that brain injuries can result from whiplash events, which do not necessarily involve impact to the head. Thus, the TC group does not represent a true zero baseline. A lifetime history of concussion was not obtained in our survey; therefore, we do not have any information on the premorbid risk in this group. We also do not know how treatment may have affected the reporting. Finally, the concussion symptom assessment used in this study was binary, and future investigations would benefit from use of the 7-point Likert scale outlined in the SCAT5.

CONCLUSIONS

From this survey of cycling crash–related injuries, we conclude that cyclists who reported a crash resulting in an HI were more likely than TCs to endorse concussion symptoms and display signs of potential HI, including damage to their helmet, loss of consciousness, and posttraumatic amnesia. Also, cyclists may be less likely to receive medical care despite signs and symptoms of concussion. As cycling is rising in popularity and carries a significant risk of traumatic injury, larger surveys of US cyclists' HIs are warranted. Based on our results, we advocate increased efforts in concussion education and monitoring in both competitive and noncompetitive cyclists, as well as baseline examination and screening for long-term behavioral health.

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REFERENCES

1. Where we ride: analysis of of bicycling in American cities, Annual American Community Survey data report for 2014. League of American Bicyclists Web site. https://www.bikeleague.org/content/where-we-ride-2014-analysis-bike-commuting. Accessed June 4, 2019.
2. Rivara FP, Thompson DC, Thompson RS. Epidemiology of bicycle injuries and risk factors for serious injury. *Inj Prev*. 2015;21(1):47–51.
3. Coronado VG, Haileyesus T, Cheng TA, et al. Trends in sports-and recreation-related traumatic brain injuries treated in US emergency departments: the National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP) 2001–2012. *J Head Trauma Rehabil*. 2015;30(3):185–197.
4. Olivier J, Creighton P. Bicycle injuries and helmet use: a systematic review and meta-analysis. *Int J Epidemiol*. 2016;46(1):278–292.
5. Reynolds CC, Harris MA, Teschke K, Cripton PA, Winters M. The impact of transportation infrastructure on bicycling injuries and crashes: a review of the literature. *Environ Health*. 2009;8:47.
6. Dinh MM, Kastelein C, Hopkins R, et al. Mechanisms, injuries and helmet use in cyclists presenting to an inner city emergency department. *Emerg Med Australas*. 2015;27(4):323–327.
7. Mather V. The BMX rider Dave Mirra, who died in a suicide, had CTE. *New York Times*. May 24, 2016.
8. McMahon PJ, Hricik A, Yue JK, et al. Symptomatology and functional outcome in mild traumatic brain injury: results from the prospective TRACK-TBI study. *J Neurotrauma*. 2014;31(1):26–33.
9. Dreier F. Kelly Catlin passes away at 23. VeloNews Web site. https://www.velonews.com/2019/03/news/kelly-catlin-passes-away-at-23_488197. Accessed March 12, 2019.
10. Meyers AC, Bhatnagar S, Robidoux G, Kotler D. Results of an online community survey on cyclist's riding and racing habits, crash history, traumatic and chronic injury, and medical treatment. *J Sci Cycl*. 2018;6(2):27–34.
11. Covassin T, Moran R, Elbin R. Sex differences in reported concussion injury rates and time loss from participation: an update of the National Collegiate Athletic Association Injury Surveillance Program from 2004–2005 through 2008–2009. *J Athl Train*. 2016;51(3):189–194.
12. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377–381.
13. Guskiewicz KM, Register-Mihalik J, McCrory P, et al. Evidence-based approach to revising the SCAT2: introducing the SCAT3. *Br J Sports Med*. 2013;47(5):289–293.
14. Echemendia R, Meeuwisse W, McCrory P, et al. The Sport Concussion Assessment Tool 5th Edition (SCAT5): background and rationale. *Br J Sports Med*. 2017;51(11):848–850.
15. Zimmer A, Marcinak J, Hibyan S, Webbe F. Normative values of major SCAT2 and SCAT3 components for a college athlete population. *Appl Neuropsychol Adult*. 2015;22(2):132–140.
16. Gorman M, Hecht S, Samborski A, Lunos S, Elias S, Stovitz SD. SCAT3 assessment of non-head injured and head injured athletes competing in a large international youth soccer tournament. *Appl Neuropsychol Child*. 2017;6(4):364–368.
17. Bin Zahid A, Hubbard M, Dammavalam VM, et al. Assessment of acute head injury in an emergency department population using Sport Concussion Assessment Tool, 3rd edition. *Appl Neuropsychol Adult*. 2018;25(2):110–119.
18. McCrory P, Meeuwisse W, Dvorak J, et al. Consensus statement on concussion in sport—the 5th International Conference on Concussion in Sport held in Berlin, October 2016. *Br J Sports Med*. 2017;51(11):838–847.
19. Brassil HE, Salvatore AP. The frequency of post-traumatic stress disorder symptoms in athletes with and without sports related concussion. *Clin Translat Med*. 2018;7(1):25.
20. Padaki AS, Noticewala MS, Levine WN, Ahmad CS, Popkin MK, Popkin CA. Prevalence of posttraumatic stress disorder symptoms among young athletes after anterior cruciate ligament rupture. *Orthop J Sports Med*. 2018;6(7):2325967118787159.
21. Ching RP, Thompson DC, Thompson RS, Thomas DJ, Chilcott WC, Rivara FP. Damage to bicycle helmets involved with crashes. *Accid Anal Prev*. 1997;29(5):555–562.
22. 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.
23. Seabury SA, Gaudette É, Goldman DP, et al. Assessment of follow-up care after emergency department presentation for mild traumatic brain injury and concussion: results from the TRACK-TBI Study. *JAMA Netw Open*. 2018;1(1):e180210.
24. Iaccarino M. Mild traumatic brain injury: a clarion call for care of the postconcussive spectrum. *JAMA Netw Ope*. 2018;1(1):e180211.
25. Thomas RE, Alves J, Vaska MM, Magalhães R. SCAT2 and SCAT3 scores at baseline and after sports-related mild brain injury/concussion: qualitative synthesis with weighted means. *BMJ Open Sport Exerc Med*. 2016;2(1):e000095.
26. Abramson AK, Brayley J, Broglio S. Concussions in cycling consensus statement. Paper presented at: Medicine of Cycling Conference; August 24–26, 2012; Colorado Springs, CO.
27. Union Cycliste Internationale. *Rules and Regulations, Part XIII: Medical Rules*. Aigle, Switzerland: Union Cycliste Internationale; 2015.
28. Greve MW, Modabber MR. An epidemic of traumatic brain injury in professional cycling: a call to action. *Clin J Sport Med*. 2012;22(2):81–82.
29. Basch CH, Zagnit EA, Rajan S, Ethan D, Basch CE. Helmet use among cyclists in New York City. *J Commun Health*. 2014;39(5):956–958.
30. Number of cyclists in the USA 2015. Statista Web site. https://www.statista.com/topics/1686/cycling/. Accessed November 8, 2016.
31. Iverson GL, Brooks BL, Ashton VL, Lange RT. Interview versus questionnaire symptom reporting in people with the postconcussion syndrome. *J Head Trauma Rehabil*. 2010;25(1):23–30.

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