

Prevalence and Epidemiology of Injuries Among Elite Cyclists in the Tour de France

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Background: Cycling injuries are increasing, particularly among elite athletes during major events such as the Tour de France. Many athletes miss considerable time from sport and require surgical intervention. Little is known about the epidemiology of injuries to guide practice participation strategies, return-to-competition expectations, and injury prevention protocols.

Purpose: To evaluate the injury epidemiology, operative incidence, and return-to-competition timeline among all elite cyclists participating in the 21-stage Tour de France race over a span of 8 years.

Study Design: Descriptive epidemiological study.

Methods: All injuries sustained during 1584 unique rides by cyclists participating in the Tour de France from 2010 to 2017 were evaluated. In the absence of an established Tour de France injury database, demographic, injury, surgical, and return-to-competition details from all athletes who withdrew because of a traumatic injury were retrospectively compiled using publicly available data, which were cross-referenced for validity. The inclusion criterion consisted of any cyclist who withdrew from the Tour de France because of an injury; cyclists who withdrew for noninjury reasons were excluded. Independent variables included injury demographics, missed days, and whether the injury required surgery. Injury prevalence, relative frequency distributions, and sample proportions were dependent metrics for this investigation.

Results: Among the 1584 cycling entries evaluated over the 8-year study period, there were 259 cyclists (16%) who withdrew (17 cyclists/year). A total of 138 withdrawals were caused by acute trauma, 49% of which were fractures ($n = 67$), which represented the most common reason for withdrawal. A total of 29 (43%) cyclists with fractures underwent surgery. The most commonly fractured bones were the clavicle ($n = 21$), followed by the wrist ($n = 6$), hand ($n = 5$), femur ($n = 5$), humerus ($n = 5$), and ribs ($n = 5$). Cyclists who underwent operative fracture fixation had a longer time between the injury and their next race compared with those who did not undergo surgery (77 vs 44 days, respectively; $P = .065$).

Conclusion: The most common injury leading to withdrawal from the Tour de France over the study period was acute fracture, comprising 49% of all injuries. Almost half of the cyclists with fractures underwent surgery. The clavicle was the most commonly fractured bone. For cyclists who underwent operative treatment of their fractures, return to competition was more than 1 month longer than for those who did not. A prospective database is warranted to catalog injuries among these elite cyclists.

Keywords: cycling; general sports trauma; medical aspects of sports; economic and decision analysis

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Cycling is a popular sport that has participants of many different ages, with a wide variety of skill and fitness levels. Elite cyclists training for and participating in major events are subject to injuries. However, little is known about the nature and frequency of injuries that these athletes endure. Improved understanding of this niche population offers the opportunity to better guide practice participation strategies, return-to-competition expectations, and injury prevention protocols. The Tour de France is 1 of the 3 “Grand Tours,” along with the Giro d’Italia and Vuelta a España, in professional cycling. Each year, 198 cyclists compete in this 21-stage race, although many of these cyclists do not complete the Tour de France because of injuries sustained during competition.²¹

Several studies have examined the most common types of injuries experienced by amateur cyclists.^{11,13,14,19,20} The most frequent acute injuries suffered by recreational

cyclists include abrasions, lacerations, contusions, fractures and dislocations, and sprains.¹⁴ Overuse injuries in amateur cyclists frequently involve the development of chronic pain, most commonly in the neck, knees, groin and buttocks, hands, and back.²⁰ The knee is the most commonly involved site of overuse injuries in cycling, with patellofemoral syndrome being the most prevalent manifestation.¹⁹ Other studies have focused specifically on the injuries in professional cyclists.^{3,4,6,8} A study conducted by De Bernardo et al⁶ over a 4-year period examined 51 cyclists, finding the prevalence of overuse and traumatic injuries to be nearly equal in top-level cyclists. The most common mechanism of a traumatic or acute injury in elite professional cyclists was falls, with the most common types of injuries being fractures, lacerations, and sprains.³ The rate of traumatic injuries in elite cyclists nearly doubled from the 1980s and early 1990s to the period 2003-2009.² Injuries due to overuse in professional cyclists most commonly affected the lower back, knee, and lower leg.⁴

The prevalence of injuries and treatment strategies of injuries among amateur cyclists have been examined in several studies.^{3,4,6,8,11,13,14,19,20} However, the overall scope of injuries suffered by professional cyclists using a single competition, namely the Tour de France, is lacking in the literature. Moreover, the frequency of their injuries leading to surgery and recovery is unknown. Thus, the goal of this retrospective study was to evaluate the injury epidemiology, operative prevalence, and return-to-sport times among all elite cyclists participating in the 21-stage Tour de France race over a span of 8 years.

METHODS

This retrospective study included all Tour de France participants from 2010 to 2017. In the absence of an official centralized injury database, we developed our own retrospective database based on publicly available data from cyclingnews.com.⁵ A total of 1584 unique rides across 739 cyclists from 2010 to 2017 were included in the analysis. Publicly available data related to cyclists' injuries, treatments, and return-to-competition times were obtained from team and tour press releases and rider interviews and were cross-referenced from other websites for accuracy, including www.velonation.com, www.bbc.com, www.cyclingweekly.com, and www.espn.com. Any discrepancies in the data were removed from analysis consideration.

A cyclist was classified as withdrawn because of an injury if he abandoned a stage or did not start a subsequent stage of the Tour de France after an injury sustained during competition. The injury type and surgical intervention were recorded for each cyclist. Cyclists for whom the injury type or surgery status after injury could not be confirmed were classified as "unknown" in these categories. Return-to-competition time was estimated for each cyclist who dropped out of the Tour de France because of an injury. The calculation of return-to-competition time was conducted by determining the number of days between the last date on which the cyclist participated in the Tour de France and the

first date of his next race. Cyclists who never participated in another race after the injury or those who had not returned to racing by the end of the 2017 season ($n = 10$) were not included.

Our database (Microsoft Excel) of all participants in the Tour de France from 2010 to 2017 included withdrawal stage, reason for withdrawal, injury sustained, surgical intervention, and date of return to cycling. Student *t* tests were used to analyze differences between cyclists who withdrew because of an injury and those who withdrew for non-injury related reasons as well as between cyclists who sustained fractures and underwent surgery versus those who did not undergo surgery. A *P* value of $<.05$ was used to define significance in comparisons between groups.

RESULTS

From 2010 to 2017, there were 1584 cycling entries in the Tour de France. Of these, there were 259 withdrawals among 212 unique cyclists (16%), for a mean rate of 17 ± 6 withdrawals per year. Acute trauma during the race led to 138 withdrawals (53%) by 118 unique cyclists, while 121 withdrawals were for nontraumatic reasons, such as non-specific illness ($n = 16$), failure to meet time cuts ($n = 16$), gastrointestinal distress ($n = 16$), and disqualification (including positive drug test results, doping, or other rule violations) ($n = 7$). The mean age of the studied group of 138 male cyclists with traumatic injuries was 30 years (range, 20-40 years).

Injury Epidemiology

The injury demographics and time to return to competition are reported in Table 1. Of the 138 withdrawals secondary to an injury, the most common types of injuries were acute fractures ($n = 67$), lacerations or contusions ($n = 17$), multiple injuries ($n = 8$), muscle strains or sprains ($n = 7$), overuse pain and inflammation ($n = 6$), and cranial trauma ($n = 3$). A total of 17 cyclists suffered injuries not listed in the previous categories, and 13 cyclists had injuries of unknown causes (Figure 1). The number of injuries resulting in withdrawal by injury type is displayed in Figure 2. Eight cyclists suffered polytrauma.

A traumatic fracture was the most common injury that resulted in withdrawal ($n = 67$). The most commonly fractured bones were the clavicle ($n = 21$), followed by the wrist ($n = 6$), hand ($n = 5$), femur ($n = 5$), humerus ($n = 5$), and ribs ($n = 5$). Several cyclists also sustained multiple fractures ($n = 6$) (Figure 3).

Prevalence of Operative Treatment

For the 67 cyclists who suffered a traumatic fracture, 43% ($n = 29$) underwent surgery. Sixteen cyclists underwent non-operative treatment after a traumatic fracture, and the type of treatment was unknown for 22 cyclists. Overall, the cyclists who underwent surgery for a fracture had a mean time between their injury and next race of 77 ± 67 days

TABLE 1
Epidemiology, Demographics, and Return-to-Competition Time by Injury Type^a

Injury Type	n	Mean Age, y	Return-to-Competition Time, d	Surgical Treatment, %	Return-to-Competition Time by Group, d		
					Surgery Group	Nonsurgery Group	P
Fracture	67	30.4	60.3	43	77.1	44.4	.065
Clavicle	21	30.2	49.0	48	37.6	75.5	.007
Wrist	6	28.4	48.7	50	45.7	N/A	
Hand	5	29.3	45.0	40	68.5	N/A	
Femur	5	31.4	129.4	100	129.4	N/A	
Rib	5	32.9	79.8	40	134.5	43.3	.1485
Humerus	5	31.2	41.0	0	N/A	46.0	
Spine	4	30.2	152.7	100	152.7	N/A	
Scapula	3	28.4	39.0	0	N/A	39.0	
Elbow	2	30.9	31.5	50	26.0	37.0	
Tibia	2	30.8	127.5	100	127.5	N/A	
Forearm	1	25.7	15.0	0	N/A	15.0	
Patella	1	37.2	N/A	100	N/A	N/A	
Pelvis	1	27.5	44.0	0	N/A	44.0	
Multiple	6	30.9	62.7	0	N/A	57.3	
Laceration/contusion	17	30.9	25.6				
Muscle sprain/strain	7	30.6	64.8				
Overuse	6	27.0	64.0				
Cranial trauma	3	30.6	29.3				
Multiple	8	32.2	88.6				
Other	17	29.7	34.1				
Unknown	13	29.7	40.4				
Total	138	30.3	52.4				

^aN/A, not available.

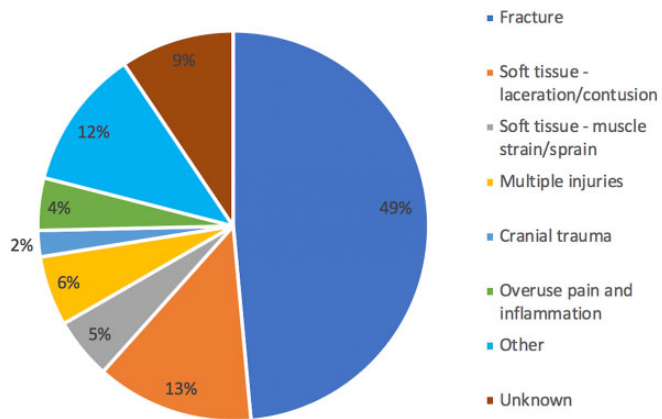


Figure 1. Injury types of cyclists who withdrew from the Tour de France from 2010 to 2017.

compared with a mean of 44 ± 20 days for cyclists who did not undergo surgery (*P* = .065). Of the 21 cyclists who sustained clavicle fractures, 10 were treated with open reduction and internal fixation. Clavicle fractures that were treated operatively had a return-to-competition time of 38 days versus 76 days for those treated nonoperatively (*P* = .007).

Return to Competition

The number of days between the last stage in which an injured cyclist participated in the Tour de France and the

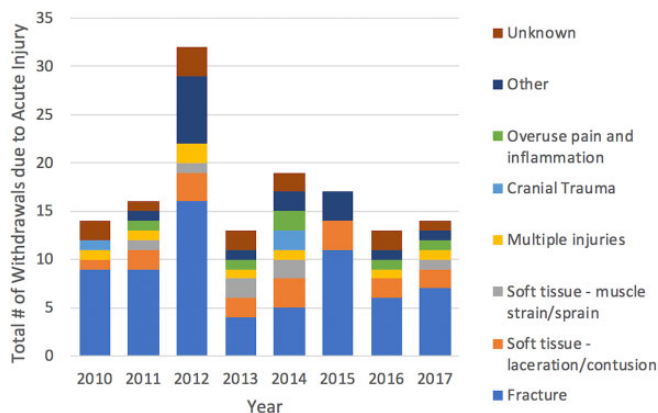


Figure 2. Types of injuries resulting in withdrawal from the Tour de France by year.

first day of his next competitive race was deemed the return-to-competition time for that athlete. The return-to-competition time varied widely (7-316 days). Cyclists who did not return after an injury were excluded from analysis (*n* = 10). The mean time to return to competition for the remaining cyclists who withdrew because of an injury (*n* = 128) was 52 ± 52 days (median, 38 days) compared with a mean return-to-competition time of 32 ± 42 days (median, 22 days) for cyclists who withdrew for non-trauma-related reasons (*n* = 121) (*P* = .004). The distribution of return-to-competition times for athletes who suffered an injury and

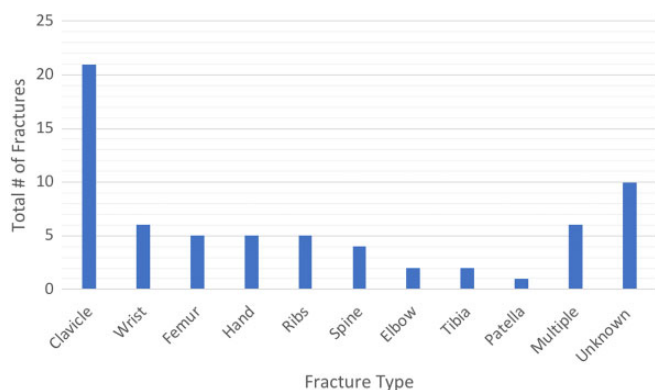


Figure 3. Distribution of fractures suffered by Tour de France cyclists from 2010 to 2017.

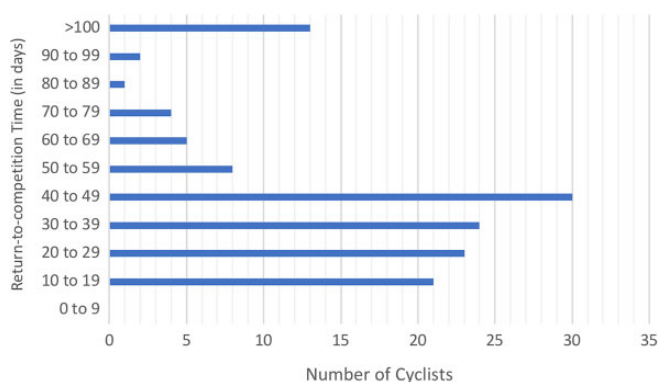


Figure 4. Return-to-competition times for cyclists who withdrew from the Tour de France because of an injury from 2010 to 2017.

returned to competitive cycling is displayed in Figure 4. Of the 10 cyclists who did not return to competition after the injury, 3 had fractures, 1 suffered a ligamentous injury to the knee, 1 chose to return to mountain biking, 1 was diagnosed with cancer, and 4 had unknown injuries.

DISCUSSION

Injuries during the Tour de France have a major impact on cyclists, with 16% of athletes withdrawing because of an injury annually. Elite cyclists are particularly susceptible to traumatic injuries because of the high speed of races, minimal protective equipment, and presence of adverse weather conditions.⁷ Yet, there is limited information in the literature that describes injury patterns in this population, with no studies to date characterizing the epidemiology of injuries sustained by professional cyclists competing in major competitions such as the Tour de France. Further, this cohort of athletes studied represents the largest group of participating professional cyclists in the modern era.

This study evaluated injuries necessitating withdrawal from the Tour de France from 2010 to 2017, including (1) injury epidemiology, (2) return-to-competition time, and

(3) fracture injuries. Over the study period, 16% of cyclists withdrew from the Tour de France because of an acute injury. In previous studies, the annual injury rate among professional cyclists ranged from 10% to 29% among 65 and 93 cyclists between 1983-1995 and 2009-2010, respectively.^{2,3} Our analysis showed that the most common injuries sustained by cyclists requiring withdrawal from the Tour de France were traumatic fractures ($n = 67$), lacerations or contusions ($n = 17$), multiple injuries ($n = 8$), and muscle sprains or strains ($n = 7$). These results are similar to those described by Barrios et al,³ with the most common injuries from 1983 to 1995 being fractures, lacerations, and sprains. A study by De Bernardo et al⁶ of cycling injuries from 2002 to 2009 described fractures (56%), lacerations or contusions (20%), and ruptures (12%) as the most common traumatic injury patterns. Over the past 35 years, the pattern of injuries in elite cycling has remained similar, as evidenced by our study.

The most common cause of traumatic injuries in cyclists is collision.⁷ The Union Cycliste Internationale has instituted rules to minimize collisions and reduce injuries, including the prohibition of cyclists from switching lanes during sprints and the requirement of rigid helmets during cycling competitions.^{10,17,18} A 2017 addendum implemented a change in the length of time used to classify a gap during sprints so that riders receive the same recorded time (from 1 to 3 seconds) in an effort to reduce collisions, although the impact of this rule change could not be assessed in this study because of the recent nature of the change.¹⁶

We found that athletes withdrawing because of an injury had a return-to-competition time of 52 days, while those who were not injured at withdrawal had a recovery period of 32 days. The most commonly fractured bones were the clavicle ($n = 21$), wrist ($n = 6$), and multiple fractures ($n = 6$). A previous study reported that the most common traumatic fractures in elite cyclists included the clavicle (22%), wrist (8%), and ribs (8%), suggesting that the fracture patterns reported in this study of the Tour de France are in agreement with those sustained in the population of elite cyclists.⁶ Overall, 43% of fracture injuries required surgery, and those undergoing surgery had a longer return-to-competition time of 77 days versus 44 days for those treated nonsurgically ($P = .065$), suggesting that the injuries being treated surgically may be more severe, as cyclists missed an additional month of competition on average. However, the time to return to competition from clavicle fractures treated operatively was significantly shorter compared with the same injury treated nonoperatively, suggesting that surgery for clavicle fractures may help cyclists return to sport more rapidly. While further details characterizing the fracture pattern are necessary, the operative fixation of clavicle fractures may allow for a quicker return to competition.

This study is not without limitations. Return-to-competition time was measured as the period before entry into the next race, making return-to-sport times dependent on the next scheduled race. Decisions to withdraw from and return to racing may have been influenced by factors that are unrelated to the current injury, including prior injuries, performance status, and prestige of individual races, and thus, more data are needed to fully understand the intricacies of

these decisions. Because specific data regarding races after the Tour de France that cyclists canceled due to injury are not publicly available, we were unable to determine the number of competition days that each cyclist missed.

In this study, the sample size of cyclists sustaining each injury type was limited, yielding results with a large degree of variation. Only injuries requiring withdrawal from the Tour de France were included in this analysis. It is estimated that approximately 10% to 30% of traumatic injuries in elite cyclists are severe, and thus, the results of this analysis may have underestimated the injury rate because of the exclusion of less severe injuries, especially those resulting from overuse, which did not lead to withdrawal.¹

As there is no consolidated publicly available database describing injuries during the Tour de France, data collection relied on press releases and rider interviews to capture descriptive statistics regarding cyclist injuries. Thus, it is possible that some injuries requiring withdrawal were not publicized and thus not included in this study. This fragmented source of information led to several unknown data points because of the inability to confirm the injury type or surgical intervention in 13 cases. Additionally, as injury-specific information is not centrally reported by physicians, detailed injury data including fracture pattern, specific surgical intervention, type of stage (flat, mountain time trial, etc), and severity of injuries were not available. Many professional sporting organizations, including the National Football League, National Basketball Association, and Major League Baseball, maintain central injury databases.^{9,12,15} A consolidated official database is needed to better understand the patterns of injuries sustained during elite cycling events and to develop methods of reducing traumatic and overuse injuries in this population.

CONCLUSION

During the 8-year study period, there were 138 withdrawals by 118 cyclists from the Tour de France because of injuries. Overall, the most common injuries were traumatic fractures, contusions or lacerations, multiple injuries, and muscle sprains or strains, which is consistent with previously described injury patterns in cycling. The mean time to return to sport was 52 days, compared with 32 days for those who withdrew for a noninjury (ie, failure to meet time cuts or positive drug test results). The most common injuries observed were clavicle fractures, multiple fractures from a single traumatic event, wrist fractures, and hand fractures. Fractures that were managed surgically had an increased return-to-competition time of approximately 1 month, suggesting that these injuries may be more severe. In the case of clavicle fractures, operative fixation provided faster return to competition than nonoperative treatment, although further analysis is required to understand which fractures benefit from operative management.

Future study is needed to better understand the mechanism of incidents resulting in injuries in professional cyclists to develop changes in equipment, rules, and repetitive use protocols, which may allow for a lower rate of injuries in the sport. Moreover, the creation of a central

injury database maintained ideally by the Union Cycliste Internationale would allow for a better understanding of the mechanism and severity of injuries in elite cyclists so as to optimize prevention strategies.

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