

Article

Twitter discourse around competitive cycling and sports-related concussion

Jack Hardwicke ^{1*}, John Batten ², Eric Anderson ² and Howard Thomas Hurst ³

¹ Centre for Physical Activity and Life Sciences, University of Northampton, Northampton, UK

² Department of Sport, Exercise and Health, University of Winchester, Winchester, UK

³ School of Sport and Wellbeing, University of Central Lancashire, Preston, UK

* Correspondence Jack Hardwicke (JH) jackhardwickephd@gmail.com

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Abstract:

The purpose of this study was to explore the competitive cycling community's online interactions with sports-related concussion. Through an analysis of twitter data ($n=196$), this study examined the discourse related to the problem of concussion in cycling. The results indicated that overall engagement and awareness of concussion in cycling was low but has been increasing year on year from 2008 to 2019. Thematic analysis of the data found three main themes within the online cycling community on Twitter: 1) Increasing awareness of concussion as a problem for the sport 2) A narrative of apathy in policy by governing bodies and 3) The need for better education as a result of misperceptions of concussion. Overall, these findings contribute to the limited research in the field of concussion in competitive cycling and outline the utility of social media as a platform to disseminate educational resources around the safe management of concussion in the sport.

Keywords: Sports-related concussion; Education; Knowledge Transfer; Cycling; Twitter research

1. Introduction

Sports-related concussion (SRC) is now seen as one of contemporary sports greatest challenges (Anderson & White, 2017) and some observe it to be threatening the existence of many of the western worlds most treasured sporting practices (Malcom, 2019). The 2017 Concussion in Sport Group define SRC as a traumatic brain injury caused by brain trauma from a biomechanical load that leads to micro-level structural damage, inhibiting the brains ability to function normally (McCrorry et al. 2017). Importantly, it presents a highly contested subject, in which many competing discourses are present; namely conflicts between health and sport (White et al., 2020). Yet, much of the literature to date sits within medical domains (Malcom, 2018) and within field-

based contact sports, such as Rugby (Gardner et al., 2014) and American Football (Harrison, 2014). Few studies have examined competitive cycling, particularly with reference to SRC and the sporting cultural narratives associated with it in cycling. However, research interest in cycling related concussion has developed over recent years, though is still in its infancy (Elliott et al., 2019; Hardwicke & Hurst, 2020; Heron et al., 2019; Hurst et al., 2018; 2019; 2020; Hardwicke et al., 2022).

Research in Mountain Biking and BMX reported that these athletes may be at risk of sub-concussive brain trauma due to the external loads experienced from the demands of the terrain and excessive head movements, which are then compounded by frequent crashes (Hurst et al., 2018, 2020). Likewise, road cycling research suggests



high rates of traumatic injury (De Bernardo et al., 2012; Barrios et al., 2014), with increasing concern around concussions in this discipline (Heron et al., 2019; Hardwicke & Hurst, 2020).

It is estimated that concussions make up 5-15% of injuries in both Mountain Biking and Road Cycling (Becker et al., 2013; Rooney et al., 2020). Additionally, health is often sacrificed in favour of sporting performance in cycling (Hurst et al., 2019; O'Reilly, 2020), whilst Dahliquist and colleagues (2015) found a high acceptance rate of injury and willingness to compete when injured amongst amateur competitive cyclists.

The growing research base and concerns relating to SRC in cycling, alongside the cultural esteem competitive sport holds, makes this area a significant, contemporary, cultural concern (Anderson & White, 2017).

Of interest to this paper, the evolution of Web 2.0 has redefined the utility of online technology and individuals' interactions with the internet. Web 2.0 refers to websites that contain user-generated content and have a participatory culture (O'Reilly, 2009). Deshpande et al. (2006) comment that it has shaped online interaction to include active engagement, collaboration, and distribution of information (Deshpande et al., 2006). Indeed, this development has seen a shift from the internet being a source of passive information distribution, to a domain of active engagement in which users can create content, critique information and transfer knowledge on open and interactive platforms (Van De Belt et al., 2010).

The platforms facilitating this include social networking sites, which allow users to communicate and exchange information, opinions, and commentaries in real time (Eysenbach, 2008), with Twitter being one of the most popular (Miller, 2009). Twitter is an accessible platform in which users 'Tweet' a range of content and 'Retweet' information, circulating it around this online community. Over half a billion tweets are sent out every day, equating to 5,787 tweets per second (Mention, 2018). Every public tweet since its inception in 2006 is held within the platform, providing a bank of data now spanning over

a decade. Here, researchers not only have access to contemporary online communities, but they can track trends over time.

A key feature to this platform is the use of key search terms and hashtags. Hashtags often come at the end of tweets and assign the tweet to a larger body of tweets under the same topic. Researchers can input key search terms or hashtags into the platform and retrieve specific data on topics. Subsequently, this large pool of data has been used extensively to research human behaviour on a global scale (Park & Macy, 2015). However, within the SRC area, there has been very little work using the available data, with those studies that do exist focusing mainly on media reporting around SRC (see; Anderson & Kian, 2012; Ahmed et al., 2017; McGannon et al., 2013; White et al., 2020).

Limited studies exist using Twitter to understand SRC. Sullivan et al. (2012) used a prospective observational study design to examine SRC content on Twitter over a seven-day period in July 2010. The researchers used eight concussion-related search terms to retrieve results. They found the most frequent theme was 'news' followed by 'sharing personal information/situation' (Sullivan et al., 2012). The study concluded that Twitter represents a powerful broadcast medium for sports concussion information and education.

More recently, Workewych et al. (2017) focused on the athlete interaction with sports-related concussion. They used Twitter data to understand public perceptions and misperceptions of SRC. Using a content and sentiment analysis of 7,483 tweets related to concussion, they found a common misperception in public understanding of concussion, with many not recognising concussion to be a form of traumatic brain injury (Workewych et al., 2017). They also stated that social media provides a useful insight to the cultural frameworks around a health issue, which can aid the implementation of prevention and treatment strategies.

Despite the concerns raised of SRC in cycling (Elliot et al., 2019), little qualitative research has been published investigating the

understanding and perceptions of SRC, with specific reference to cycling. As such, the purpose of this study was to explore the discourses around SRC in competitive cycling through a thematic analysis of Twitter data.

2. Materials and Methods

A qualitative content analysis was used, analysing publicly available cycling-specific and concussion-related tweets posted on the Twitter platform. No contact was made between the researchers and the twitter users. No specific time frame was adopted due to the limited overall number of specific tweets available, but data after 31st December 2019 was not examined to enable only complete years to be included in the analysis. Only tweets relating specifically to competitive cycling were included for analysis, with recreational and transport cycling related content being excluded.

Both scientific and colloquial terms were used to yield the data, as the study aimed to capture the wide array of Twitter users that interact with this area, namely researchers, athletes, and the general public. After scoping the available data and trialing a range of search terms, the following 7 key search terms were used to obtain the data: “Concussion in cycling” “Traumatic Brain Injury in Cycling” “TBI Pro Cycling” “Concussion British Cycling” “Concussion UCI” “Head Injury Cycling” and “Concussion Cycling Crash”. The Boolean operator ‘And’ was used between key search terms. Each key term was searched systematically, working chronologically through all retrieved results until saturation. The seven key search terms retrieved 201 tweets from January 2008 to December 2019.

Analysis

Twitter data was manually collated into a data template on Microsoft Excel (2016). The template included the search term, date, and relationship to the topic, as well as user gender, if identifiable. The relationship to the topic was broken down into 8 categories: Academic Researcher, Athlete, Parent, Journalist, Cycling News Reporting

Organisation, Cycling Company, Concussion Specific Organisation, or Other.

Data was collected by the lead author over a two-week period in short sessions to reduce fatigue and ensure a constant focus.

Data was manually analysed to allow for immersion into the research context to understand the data and the construction of themes. Primary (discourse) analysis involved general descriptive analysis of data, with initial code production. Emergent themes and sub-themes were then more closely analysed, drawing on a thematic analysis of Twitter data to produce the final emergent themes (Braun & Clarke, 2019).

Following a reflexive analytical approach (Braun & Clarke, 2019), the coding scheme was created and adapted throughout the data collection phase with the aim of collating data within emergent themes. All twitter data was anonymised – despite it being public data – with no personal information used. Due to the research area, and the sensitivities around concussion, a pragmatic approach to user content was employed; whereby anything deemed personal and/or sensitive was not included in the study. After initial scoping of the data, 5 tweets were taken out before analysis due to the above concerns, leaving the final sample of 196. Table 1 details the primary codes used and rationale for each.

3. Results

3.1. Search Results

The largest number of tweets were collected in 2019 (27%), with a consistent decline in Twitter activity with each year working backwards to 2008 (See Figure 1).

The dominant groups interacting with this area were in the category ‘Other’ (40%). This referred to a Twitter user that had no clear affiliation to the sport. Second, were ‘Researchers’ (27%), followed by ‘Cycling News Reporting Organisations’ (16%). Athletes made up only 7% of the sample. Table 2 presents an overview of these users.

The gender distribution of the sample was predominately male ($n=115$, 58%),

followed by unidentifiable accounts or organisations ($n=63$, 32%), and female ($n=18$, 9%) users.

3.2. Discourse Results

Policy and Protocols

The leading discourse found in the data included discussions concerning policy and protocols in competitive cycling (40%). Here, two sub-themes were present. First, was policy curiosity:

- *Just saw the @richie_porte and @DanMartin86 crash in @LeTour. @thejensie and @NBCSNcycling does @UCI_cycling have a concussion protocol?*
- *What's the UCI concussion protocol? Watching Tom stumble through the line of descending riders was terrifying.*
- *Is there actually a concussion protocol in place in the UCI World Tour or cycling in general?*

Table 1. Description of coding strategy.

Code	Description	Example tweets
Policy and Protocol	Commentary on policy or protocol related to concussion in competitive cycling.	<i>New@HeadCheckHealth #concussion blog out! "Unfortunately, there is no internationally agreed-upon protocol for concussion in cycling." #cycling</i> <i>Thinking out loud: What is Uci doing minimising head concussions in cycling? For example, incorporating MIPS in helmets would make a difference for starters.</i>
Reporting	News article, journalist commentary or media reporting.	<i>We spoke to @bikeradar to raise awareness of #Concussion in #Cycling:</i> http://bikeradar.com/commuting/gear/article/concussion-and-cycling-48185/ #ConcussionAware #Education #UseYourHead <i>Another honest, true reflection of the impact of concussion in pro cycling from @user. It's great that these discussions are being had to increase awareness around concussion and concussion management. However, the sport needs more focus around this topic.</i>
Crash Reporting	Reports of crashes that included an athlete that had sustained a concussion.	<i>Concussion in cycling: Toms Skujins: Latvian rider out of Tour of California after heavy crash</i> http://bbc.co.uk/sport/cycling/39939952 <i>Horner in hospital with concussion, may be forced out of Tour de France</i> http://goo.gl/fb/IgqLg #cycling
Publications	Any research outputs such as journals, reports, or blogs.	<i>Little article I co-write with @user on concussion in cycling</i> https://theconversation.com/amp/tour-de-france-does-pro-cycling-have-a-concussion-problem-100419?twitter_impression=true <i>My first concussion blog post is live! The goal of this blog series is to raise awareness about concussion prevalence in cycling and educate the community about how to prevent, identify, and recover from concussions.</i>

The second sub-theme was the expression of animosity towards the lack of policy in place and/or being enforced in the sport:

- @UCI_cycling has a major organizational problem if a racer with an obvious concussion is allowed to

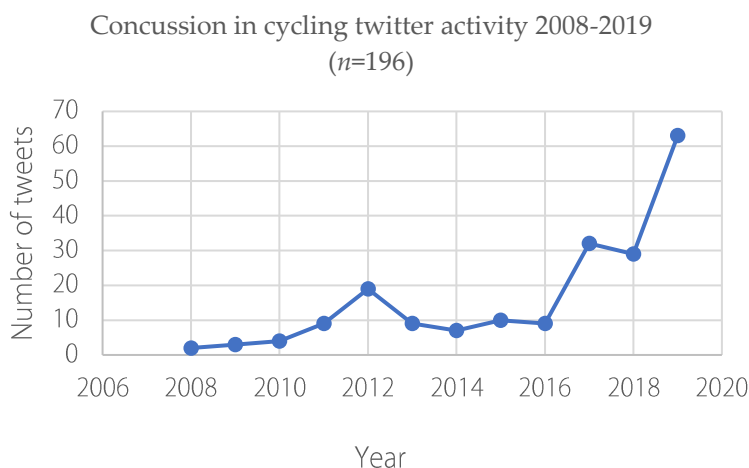


Figure 1. Twitter activity over the years of data collected.

Table 2. Stakeholders interacting with keyword searches.

Relation to Cycling	Number of Tweets
Other	78 (40%)
Researcher	53 (27%)
Cycling News Reporting Organisation	31 (16%)
Athlete	13 (7%)
Concussion Specific Organisation	8 (4%)
Journalist	6 (3%)
Cycling Company	3 (1.5%)
Cycling Team	2 (1%)
Cycling Shop	1 (0.5%)
Governing Body	1 (0.5%)

continue racing.

- Does the UCI have a concussion protocol such as SCAT? Searching concussion on their website yields no results! In honesty I think the best place to start with this is education for the athlete and the support network. A concrete protocol would help too...
- I wish you took concussion seriously, same goes across Cycling. It's treated as not so when if we called it a traumatic brain injury then it would be taken more

so. The tests taken still mean sit them out. You only have to look at other sports for the damage it does.

- With the increased knowledge re concussion and dangers of follow up knocks, this seems a crazy risk by Martin, his team and the UCI!

Reporting

The second most common discourse was reporting (23%) on concussion, which included news articles, journalist commentaries, or media reports. These tweets covered a wide range of topics within concussion in cycling, with blogs or articles being shared and commented on. Again, two sub-themes were present. First, levels of awareness was a clear discourse across a range of twitter users:

- Dealing with concussion in cycling -- http://podiumcafe.com/2017/5/16/15647534/dealing-with-concussion-in-cycling?utm_campaign=podiumcafe&utm_content=fan-post%3Aatop&utm_medium=social&utm_source=twitter via @PodiumCafe
- Pro Cycling Plagued by Head Injuries | Cyclingnews.com: <http://bit.ly/pAMfKY> >>head injury assessment.
- Concussion is a hot topic in sport at the moment. But road cycling is often left out of the conversation, which tends to be far more focussed on contact team sports. Conor set out to open up the conversation around concussion with two experienced riders

The second sub-theme involved commentary on the experiences or events around a rider that had suffered a concussion:

- Concussion in cycling, another career ending example of the seriousness of this "silent" condition. "I have symptoms

every day, now nine months later. My career as a cyclist is over."

- *Kelly Catlin's tragic story underscores the seriousness of traumatic brain injuries. Her family says the three-time world cycling champion committed suicide after struggling with depression and after-effects of a #concussion sustained in a cycling crash.*
- *A scary crash led to a yearlong #concussion recovery for @user and her retirement from pro cycling. She learned plenty of lessons in her concussion journey and is sharing them in this week's #ConcussionHope sequence! Hear her story and the importance of patience:*

Crash Reporting

The third discourse was crash reporting (16%). Although discourses around the second theme were more concerned with the experiences of concussion, this theme was purely factual reporting of incidents in professional cycling that resulted in a concussion. For example:

- *Cyclist Graham Charlton is back cycling again after suffering with a traumatic brain injury: from @cyclingweekly*
- *Pozzovivo suffers concussion in Fleche Wallonne crash #cycling*
<http://cyclingnews.com/news/pozzovivo-suffers-concussion-in-fleche-wallonne-crash/>
- *Niki Terpstra will miss Paris Roubaix after suffering 'severe #concussion' in Tour of Flanders crash - Cycling Weekly*
<https://buff.ly/2IrT64i> #DDFUND

Publications

The final discourse from the initial descriptive coding was publications (15%). This concerned any tweets relating to research outputs such as journals, reports, or blogs. Additionally, commentary around these outputs were included under this theme. For example:

- *Sports-related concussion (SRC) assessment in road cycling: a systematic review and call to action*

- *New Article: An Epidemic of Traumatic Brain Injury in Professional Cycling: A Call to Action: No abstract available*
<http://bit.ly/zmlzMI>
- *Concussion in cycling*
<http://medicineofcycling.com/wp-content/uploads/2012/01/ConcussionsInCyclists2012.pdf>

3.3. Thematic Analysis

A thematic analysis (Braun & Clark, 2019) of the data resulted in three main themes: "Increasing Awareness", "A Narrative of Apathy in Policy" and "Education and Misperceptions".

Increasing Awareness

Following a thematic analysis of the data, it was found that the relatively small data set obtainable ($n=196$) potentially reflects the lower overall levels of awareness of SRC in cycling. Yet, despite this, the analysis did find rising engagement and awareness of this issue within the cycling community. Specifically, increasing levels of Twitter activity were observed year on year, with a clear increase from 2016 onwards (see Figure 1).

Interestingly, we found reactive discourse in the data, with three key events possibly contributing to increased Twitter engagement. In 2012, Abramson et al. (2012), under the scope of the Cycling Concussion Task Force, released a Concussion in Cycling Consensus Statement. This document discussed best practice for concussion awareness and management in cycling. The release of the document stimulated a spike in tweets, with conversations around the issue being instigated.

The second spike, in 2017, concerned an infamous crash involving Tom Skujins in the Tour of California. Skujins was involved in a crash that included a head impact, which was caught on camera, with the video proceeding to show Skujins returning to his bike dazed and unsteady on his feet. A mechanic aids him back onto his bike and he remounts in an attempt to re-join the race. The event again resulted in a spike in Twitter data, with

commentaries around the mismanagement of the injury and questions about the protocols in place for such events. One significant tweet states *'if you're referring to the skuijns crash I think it is an incident that should be learned from by changing the concussion culture of cycling'*.

The final spike within the data came in 2019. This spike was probably multicausal, though appeared to be spearheaded by the passing of young American Track Cyclist, Kelly Caitlin, whose death was attributed to the mismanagement of concussive injuries (CLF, 2019). Again, this instigated a discussion around the policy and role of the governing bodies in enforcing policy to prevent such events. These spikes in activity can be seen clearly in Figure 1.

A Narrative of Apathy in Policy

The second theme was around concussion policy in competitive cycling, and the apathy of the governing bodies to manage this injury. Indeed, most Twitter activity (40%) was around this issue. We first see discussions around this in 2011, and every year since has included debates, discussions, and calls to action around concussion policy and implementation in competitive cycling.

Tweets either directly questioned the UCI or suggested wider questioning about concussion policies in cycling. These discussions brought to light the invisibility of policy and lack of effective implementation in competitive cycling. This is problematic, as the sport cannot start to effectively deal with the problem and raise awareness without clear and overt policy being implemented for fans, athletes, and stakeholders to view. Example tweets included:

- *Is there actually a concussion protocol in place in the UCI World Tour or cycling in general?*
- *Is pro #cycling waiting for something to happen to a rider before it does something about #concussion post crash!?!? #giroditalia2014*
- *Moments after Skujins crash. Concussion protocol? Cycling again*

showing it is years behind other sports in the safety of it's athletes.

Several discussions around the management of concussion by governing bodies and a concern for rider health were found in the data. Here, we see a discourse around the impact a lack of policy was having on rider health, with several people in the cycling community outspoken on this issue. Example tweets include:

- *When it comes to riders' health, cycling management has a "they're disposable" attitude. It is shocking that cycling, a sport that has an inherent crash issue, still has no official concussion protocol to protect its men and women. #RidersAreDisposable'.*
- *Not that this is anything new, but pro sports need to step their shit up with concussions. UCI and AMA both let riders compete after. Sad!*
- *Louis Meintjes should never have been allowed back on the bike after that crash. Looked completely dazed. Get serious about concussions Pro Cycling*

Education and Misperceptions

The final theme was around education and misperceptions. In terms of education, there were limited cycling specific resources or informational tweets for cyclists to follow if suffering from a concussion. However, from analysis of the data, it was apparent that most of the community concerned with the injury had good levels of understanding of the injury and its severity. Although, of course, those with this knowledge are perhaps more likely to be the ones commenting on the subject.

A misperception present was around the risk and rates of concussion in cycling. The lack of injury surveillance in cycling (Rooney et al., 2020), paired with the difficulties in concussion diagnosis (McCory et al., 2017), makes understanding the true rates and frequency of the injury in competitive cycling a difficult task. However, there is literature that shows competitive cyclists have high rates of crashes, traumatic

injuries, and self-reported concussions (Silberman, 2013; Rice et al., 2020; Hurst et al., 2018; Hardwicke & Hurst, 2020).

Through the content analysis and observations, there appeared to be a dissociation between concussion and cycling. This aligns with the wider cultural detachment, which often assigns concerns of concussion with contact and combat sports and not cycle sports. One particular tweet exemplifies this misperception:

- *Mate, you literally said “Crashes are fairly common in cycling, as are concussions”. I appreciate you have personal experience with concussion. But context please: in no sane universe is concussion in cycling ‘common’. It happens, but it’s rare. Like once-in-a-million-miles rare.*

Without visible policy, concentrated efforts from governing bodies, and an understanding that cyclists are a high-risk group for concussion, action in relation to SRC management and prevention in competitive cycling will likely remain problematic.

4. Discussion

The purpose of this study was to understand online discourses around SRC in competitive cycling. The research design was selected to allow for greater freedom in the exploration of data. Although available data was limited, the assertion that competitive cycling has a concussion problem is supported by the research findings. Indeed, there appears to be a collective concern and increasing awareness around the issue. Specifically, a thematic analysis of the data presented three main themes: “Increasing Awareness”, “A Narrative of Apathy in Policy” and “Education and Misperceptions”.

The findings presented in this paper show that, compared to other sports, twitter activity around concussion in competitive cycling is significantly lower, reflecting the position of the sport in wider cultural

narratives. Whilst few studies in this area have been done, and none that are sport specific, Workewych et al. (2017) work shows this. The study collected data from just one month in 2013 and retrieved 7483 tweets that were mostly from contact and field sports, namely American Football, Hockey, Boxing and Rugby. However, the current study found that awareness *is* growing in cycling.

Data suggests that there has been concern around the governing bodies dealing with the injury for nearly a decade, with many in the community feeling let down and angered by this. Further, there is a need for greater education around SRC, with several misperceptions existing, potentially because of the lower levels of awareness present in the sport. These results add to previous literature around misperceptions that exist amongst cyclists regarding concussion incidence, risks, and attitudes (Hardwicke & Hurst, 2020; O’Reilly et al., 2020; Hardwicke et al., 2022).

Sullivan and colleagues (2012) supported the notion that twitter offers a powerful platform for the promotion of educational resources for sports-related concussion, further supported by work from Workewych et al. (2017). Following this assertion, social media may offer a platform to address the low levels of awareness and dangerous attitudes around concussion in cycling that previous research has highlighted (Hurst et al., 2018; Hardwicke & Hurst, 2020). At present, this opportunity is being missed and there exists very limited educational resources for cycling-specific concussion issues, with limited engagement from governing bodies. This becomes crucial as not only does continuing to compete following a suspected SRC place the individual at increased injury risk and disrupted recovery, but others in the peloton. The immediate effect on cognitive function from a concussive injury is now widely understood in the literature. Here, when a cyclist continues to race following a crash in an already demanding environment, the deficit in cognitive function puts them at greater risk of crashing again, or causing a crash through a mistake (Silberman, 2013).

In addition to this concern, this study reinforces the need for greater policy attention in competitive cycling. Specifically, these findings show the consistent trend of pressure being put on the UCI to act and implement more effective concussion policy, as well as enforce it. This has been ongoing with impetus since 2011, yet many athletes continue to be put at risk from a lack of policy (Heron et al., 2019). There have been numerous calls for this to be reviewed within the literature, and this study contributes to the voice of athletes, clinicians and other stakeholders that also echo this sentiment. Further, whilst data from the current study had limited discussion in the UK context, a recent scoping review from Scullion and Heron (2022) on concussion guidelines in amateur sports in the UK found British Cycling to be one of only two governing bodies to not have published SRC guidelines available to the public. This shows the above concern is also relevant in the UK competitive cycling context.

It is, however, worth noting that the UCI have recently released new policy on concussion management in the sport, though this was after the data collection period for this study (UCI, 2020). Yet, the primary focus of this policy is clearly on the most popular discipline of road cycling, and whilst other disciplines, such as Mountain biking and Cyclocross are very briefly alluded to within the document, limited consideration appears to have been given to the unique challenges of monitoring and dealing with SRC within these disciplines, with 'general' guidance available for all disciplines. Therefore, future research is warranted to establish the impact of this new policy and whether the discourse examined in this study is influenced by this policy over the coming years. At the same time, an examination of policy impact across cycling disciplines would be welcome.

Unfortunately, misperceptions around concussion risk and frequency in cycling also suggests the need for further research in this area. Indeed, there remains a need to understand concussion frequency in competitive cycling, with centralised injury surveillance required, alongside an

evidenced based cycling-specific concussion diagnosis protocol that reinforces UCI policy around removing riders from competition when they show signs of concussion (UCI, 2020).

As mentioned throughout the paper, this is a novel field within SRC research, and the current study is one of a few studies looking at SRC in cycling. Whilst the sample in this study is too small to conduct the analysis, we agree with one of the reviewer's comments that an interesting future direction would be to assess any difference in the discourse around concussion from differing groups. Future research could follow this line of inquiry drawing on wider data sources such as Facebook, news articles comments and YouTube. This could build on the work of Hardwicke and Hurst (2020) who found differences in concussion attitudes amongst age and ability groups. An analysis between discourses amongst the cycling public (fans/general observers), athletes (all levels) and the professional level would be an interesting direction for future work.

5. Practical applications

This research found clear gaps in knowledge and misconceptions relating to cycling and SRC based on the Twitter discourse analysed. Nevertheless, social media platforms might help with the dissemination of targeted educational resources to address these issues and provide timely updates on new policy from both global and regional organisations. Further, the study shows the cycling public and stakeholders are increasingly interested in, and engaged with, SRC. As such, governing bodies should consider this when shaping policy going forward and implementing it (e.g. what are fans viewing on televised events in regard to protocol implementation).

6. Conclusions

This study highlights that competitive cycling is behind other sports in dealing with the current concussion crisis. Thus, greater efforts are needed from governing bodies in

the sport to increase the level of awareness and educate stakeholders on the risks of SRC in cycling. Social media outlets, such as Twitter, also provide a simple platform through which knowledge might be shared with various stakeholders and is something that governing bodies should seek to embrace.

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References

1. Abramson M. (2012, September 14). *Homepage - Medicine Of Cycling*. Concussion in Cycling Consensus Statement 2012. <https://www.medicineofcycling.com/>
2. Ahmed OH, Schneiders AG, McCrory PR, Sullivan SJ. Sport Concussion Management Using Facebook: A Feasibility Study of an Innovative Adjunct “iCon”. *J Athl Train* 2017; 52(4): 339–349. <https://doi.org/10.4085/1062-6050-52.2.13>
3. Anderson E, Kian EM. Examining Media Contestation of Masculinity and Head Trauma in the National Football League. *Men Masc* 2012; 15(2): 152–173. <https://doi.org/10.1177/1097184x11430127>
4. Anderson E, White A. *Sport, Theory and Social Problems (2nd Ed.)*. Routledge, UK, 2017.
5. Barrios C, Bernardo N, Vera P, Laíz C, Hadala M. Changes in Sports Injuries Incidence over Time in World-class Road Cyclists. *Int J Sports Med* 2014; 36(03): 241–248. <https://doi.org/10.1055/s-0034-1389983>
6. Becker J, Runer A, Neunhäuserer D et al. A prospective study of downhill mountain biking injuries. *Br J Sports Med* 2013; 47: 458–462.
7. Braun V, Clarke V. Reflecting on reflexive thematic analysis. *Qual Res Sport Exer Health* 2019; 11(4): 589–597. <https://doi.org/10.1080/2159676x.2019.1628806>
8. Dahlquist M, Leisz M-C, Finkelstein M. The Club-Level Road Cyclist. *Clin J Sport Med* 2015; 25(2): 88–94. <https://doi.org/10.1097/jsm.0000000000000111>
9. De Bernardo N, Barrios C, Vera P, Laíz C, Hadala M. Incidence and risk for traumatic and overuse injuries in top-level road cyclists. *J Sports Sci* 2012; 30(10): 1047–1053. <https://doi.org/10.1080/02640414.2012.687112>
10. Deshpande A, Jadad AR. Web 2.0: Could it help move the health system into the 21st century? *J Mens Health Gend* 2006; 3(4): 332–336. <https://doi.org/10.1016/j.jmhg.2006.09.004>
11. Elliott J, Anderson R, Collins S, Heron N. Sports-related concussion (SRC) assessment in road cycling: a systematic review and call to action. *BMJ Open Sport Exer Med* 2019; 5(1): e000525. <https://doi.org/10.1136/bmjsem-2019-000525>
12. Eysenbach G. Medicine 2.0: Social Networking, Collaboration, Participation, Apomediation, and Openness. *J Med Internet Res* 2008; 10(3): e22. <https://doi.org/10.2196/jmir.1030>
13. Gardner, A.J.; Iverson, G.L.; Williams, W.H.; Baker, S.; Stanwell, P. A Systematic Review and Meta-Analysis of Concussion in Rugby Union. *Sports Med*. 2014, 44, 1717–1731. <https://doi.org/10.1007/s40279-014-0233-3>.
14. Hardwicke J, Hurst H. Concussion knowledge and attitudes amongst competitive cyclists. *J Sci Cycl* 2020; 9(3): 53–66. <https://doi.org/10.28985/1220.jsc.05>
15. Hardwicke, J., Baxter, B. A., Gamble, T., & Hurst, H. T. (2022). An Investigation into Helmet Use, Perceptions of Sports-Related Concussion, and Seeking Medical Care for Head Injury amongst Competitive Cyclists. *International Journal of Environmental Research and Public Health*, 19(5), 2861. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/ijerph19052861>
16. Harrison, E.A. The First Concussion Crisis: Head Injury and Evidence in Early American Football. *Am. J. Public Health* 2014, 104, 822–833. <https://doi.org/10.2105/ajph.2013.301840>.
17. Heron N, Elliott J, Jones N, Loosemore M, Kemp S. Sports-related concussion (SRC) in road cycling: the Roadside head Injury assessment (RIDE) for elite road cycling. *Br J Sports Med* 2019; 54(3): 127–128. <https://doi.org/10.1136/bjsports-2019-101455>
18. Hurst HT, Atkins S, Dickinson BD. The magnitude of translational and rotational head accelerations experienced by riders during downhill mountain biking. *J Sci Med Sport* 2018; 21(12): 1256–1261. <https://doi.org/10.1016/j.jsams.2018.03.007>
19. Hurst HT, Hancock S, Hardwicke J, Anderson E. Does participation in Downhill mountain biking affect measures of executive function? *J Sci Cycl* 2020; 9(3): 83–93. <https://doi.org/10.28985/1220.jsc.04>

20. Hurst HT, Novak AR, Cheung SS, Atkins S. Knowledge of and attitudes towards concussion in cycling: A preliminary study. *J Sci Cycl* 2019; 8(1): 11–17. <https://doi.org/10.28985/1906.jsc.03>
21. Kelly Catlin. (2019, February 23). Concussion Legacy Foundation.
22. Malcolm D. Concussion in Sport: Public, Professional and Critical Sociologies. *Sociol Sport J* 2018; 35(2): 141–148. <https://doi.org/10.1123/ssj.2017-0113>
23. Malcolm D. *The Concussion Crisis in Sport (1st Ed.)*. Routledge, UK, 2019.
24. McCrory P, Meeuwisse W, Dvorak J ř, Aubry M, Bailes J, Broglio S, Cantu RC, Cassidy D, Echemendia RJ, Castellani RJ, Davis GA, Ellenbogen R, Emery C, Engebretsen L, Feddermann-Demont N, Giza CC, Guskiewicz KM, Herring S, Iverson GL, ... Vos PE. Consensus statement on concussion in sport – the 5th international conference on concussion in sport held in Berlin, October 2016. *Br J Sports Med* 2017; bjsports-2017. <https://doi.org/10.1136/bjsports-2017-097699>
25. McGannon KR, Cunningham S., Schinke RJ. Understanding concussion in socio-cultural context: A media analysis of a National Hockey League star’s concussion. *Psychology of Sport and Exercise* 2013; 14(6): 891–899. <https://doi.org/10.1016/j.psychsport.2013.08.003>
26. Mention. (2018). *Mention’s Twitter Engagement Report* 2018. <https://Info.Mention.Com/Twitter-Report>. <https://info.mention.com/twitter-report>
27. Miller CC. (2009, August 26). *Who’s Driving Twitter’s Popularity? Not Teenagers*. The New York Times. <https://www.nytimes.com/2009/08/26/technology/internet/26twitter.html>
28. O’Reilly M, Mahon S, Reid D, Hume P, Hardaker N, Theadom, A. Knowledge, attitudes, and behavior toward concussion in adult cyclists. *Brain Injury* 2020; 34(9): 1175–1182. <https://doi.org/10.1080/02699052.2020.1793386>
29. O’Reilly, T. (2009). What is Web 2.0. Van Duuren Media.
30. Park P, Macy M. The paradox of active users. *Big Data Soc* 2015; 2(2): 205395171560616. <https://doi.org/10.1177/2053951715606164>
31. Rice S, Iaccarino MA, Bhatnagar S, Robidoux G, Zafonte R, Kotler DH. Reporting of Concussion-Like Symptoms After Cycling Crashes: A Survey of Competitive and Recreational Cyclists. *J Athl Train* 2020; 55(1): 11–16. <https://doi.org/10.4085/1062-6050-91-19>
32. Rooney D, Sarriegui I, Heron N. ‘As easy as riding a bike’: a systematic review of injuries and illness in road cycling. *BMJ Open Sport Exer Med* 2020; 6(1): e000840. <https://doi.org/10.1136/bmjsem-2020-000840>
33. Scullion, E.; Heron, N. A Scoping Review of Concussion Guidelines in Amateur Sports in the United Kingdom. *Int. J. Environ. Res. Public Health* 2022, 19, 1072. <https://doi.org/10.3390/ijerph19031072>.
34. Silberman MR. Bicycling Injuries. *Curr Sports Med Rep* 2013; 12(5): 337–345. <https://doi.org/10.1249/jsr.0b013e3182a4bab7>
35. Sullivan SJ, Schneiders AG, Cheang C-W, Kitto E, Lee H, Redhead J, Ward S, Ahmed OH, McCrory PR. (2012). ‘What’s happening?’ A content analysis of concussion-related traffic on Twitter. *Br J Sports Med* 2012; 46(4): 258–263. <https://doi.org/10.1136/bjsem.2010.080341>
36. Thomas DR. A General Inductive Approach for Analyzing Qualitative Evaluation Data. *Am J Eval* 2006; 27(2): 237–246. <https://doi.org/10.1177/1098214005283748>
37. UCI (2020). *A new protocol specific for cycling to deal with concussion* (<https://www.uci.org/inside-uci/press-releases/a-new-protocol-specific-for-cycling-to-deal-with-concussion>)
38. Van De Belt TH, Engelen LJLPG, Berben SAA, Schoonhoven L. Definition of Health 2.0 and Medicine 2.0: A Systematic Review. *J Med Internet Res* 2010; 12(2): e18. <https://doi.org/10.2196/jmir.1350>
39. White AJ, Parry, KD, Humphries C, Phelan S, Batten J, Magrath R. Duty of Karius: Media Framing of Concussion Following the 2018 UEFA Champions League Final. *Commun Sport* 2020; 216747952094804. <https://doi.org/10.1177/2167479520948048>
40. Workewych AM, Ciuffetelli Muzzi M, Jing R, Zhang S, Topolovec-Vranic J, Cusimano MD. Twitter and traumatic brain injury: A content and sentiment analysis of tweets pertaining to sport-related brain injury. *SAGE Open Med* 2017; 5: 205031211772005. <https://doi.org/10.1177/2050312117720057>