

X as a proxy for tackle safety culture? Sentiment analysis of social media posts on red-carded and yellow-carded tackles during the 2019 Rugby World Cup

Firdows Alexander,¹ Ross Tucker,^{2,3} Ben Jones ,^{1,4,5,6,7} Sharief Hendricks ^{1,4}

To cite: Alexander F, Tucker R, Jones B, *et al.* X as a proxy for tackle safety culture? Sentiment analysis of social media posts on red-carded and yellow-carded tackles during the 2019 Rugby World Cup. *BMJ Open Sport & Exercise Medicine* 2023;**9**:e001756. doi:10.1136/bmjsem-2023-001756

Accepted 19 October 2023

ABSTRACT

Objectives This study analysed the overall sentiment of attitudes, opinions, views and emotions expressed in posts on X related to red-carded and yellow-carded tackles during the 2019 Rugby World Cup (RWC).

Methods Sentiment analysis was conducted on posts on X about red or yellow cards issued at the 2019 RWC. Posts were classified as 'agree', 'disagree' and 'neutral'. The frequency of posts, red cards, yellow cards, all injuries, tackle injuries and total number of tackles per match were also synced to the 45-match playing schedule.

Results Five tackle-related red cards were issued during the 2019 RWC, and 15 tackle-related yellow cards, with 337 and 302 posts identified for each card decision, respectively. For red cards, 42% of posts (n=158/377) agreed with the referee's decision, 19% (n=71/377) disagreed and 40% were neutral. For yellow cards, 24% (n=73/302) agreed with the referee's decision, 33% (n=99/302) disagreed and 43% were neutral.

Conclusions For red cards, posts were 2.2 times more likely to agree with the referee's decision than disagree. Posts that agreed with a red card decision were also more likely to be shared (reposted) than posts that disagreed with a red card decision. In contrast, sentiments expressed for yellow card decisions were mixed. This may be related to interpreting the degree of danger and whether mitigation is applied. Within the ecosystem of rugby, sharing sentiments on social media plays a powerful role in creating a positive player welfare narrative.

INTRODUCTION

Rugby union is a global sport with approximately 9.6 million players in 124 countries.¹ World Rugby's flagship tournaments are the Men's and Women's Rugby World Cups (RWC), held every 4 years and considered international mega-sporting events. In 2019 the ninth Men's RWC occurred in Japan from 20 September to 2 November. Comprehensive injury surveillance is conducted at all these RWCs.²⁻⁵ These injury surveillance studies have documented a high injury incidence, with concussion as the most common injury.²⁻⁵ During the 2019 RWC, concussions accounted for 15% of all injuries, while the

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Rugby union has a high risk of concussion, which is largely a result of dangerous tackles.
- ⇒ The sport's governing body, World Rugby, implemented a referee decision-making framework to improve the sanctioning of these dangerous tackles.
- ⇒ Based on its widespread use, content and influential nature, social media can serve as a proxy to understand the current culture around a topic.

WHAT THIS STUDY ADDS

- ⇒ For red cards, posts were 2.2 times more likely to agree with the referee's decision than disagree.
- ⇒ Posts that agreed with a red card decision were also more likely to be shared (reposted) than posts that disagreed with a red card decision.
- ⇒ In contrast, sentiments expressed for yellow card decisions were mixed. This may be related to interpreting the degree of danger and whether mitigation was applied.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ The proportion of posts that agreed with the referee's decision to issue red cards compared with yellow cards and the sharing of these sentiments suggests that changing the culture within the sport is possible.
- ⇒ Future sports injury prevention studies can build on this study in terms of evaluating the culture when safety initiatives and policies are introduced.
- ⇒ Governing bodies can leverage social media strategies to create awareness and understanding to promote a positive player narrative.

most common injury location was the head/neck (27%). This consistent finding and growing concern over the long-term implications of cumulative head impacts⁶ has led to the introduction of several concussion prevention initiatives in recent years.

These initiatives have included stricter sanctioning of foul play where the tackler impacts the ball-carrier's head during high or charging tackles (those that do not involve using the arms).⁷⁻⁹ These high tackles or



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to

Dr Sharief Hendricks;
sharief.hendricks01@gmail.com

charging tackles had been documented to have a significantly greater risk of causing concussion. So applying the high tackle law was viewed as a means to directly reduce concussion incidence.⁷ In addition, studies that had examined the risk factors for head injuries and concussions in the sport had revealed that upright tacklers and higher contact tackles where the tackler's head and the ball-carrier's head or shoulders were in close proximity were significantly more likely to result in head injuries than when tacklers were bent and made lower contact on the ball-carrier's body.^{8,9}

In 2016, World Rugby presented the risk factors for head injury to a group of coaches and players, who advised that a stricter application of the high tackle laws might be considered as a means to change behaviour by lowering the height of the tackle, which would protect both the ball-carrier (whose head would be impacted less often) and the tackler (whose head would be in the relatively safer proximity of the ball-carrier's torso). This zero-tolerance directive was introduced in 2017⁷ and caused a significant increase in the number of yellow and red cards given for high tackles.

Given the impact of a red card (the player is sent from the field for the remainder of the match without the option of a replacement) and a yellow card (the player is sent from the field for 10 min), red and yellow cards are perceived very negatively by teams who receive them, as well as their fans. At the end of the 2018 season, intracompetition and intercompetition card decision inconsistencies were noted.⁷ These inconsistencies would undermine the behaviour change message and compromise public understanding and approval of the intention of sanctions as a concussion prevention initiative. World Rugby introduced the High Tackle Sanction Framework (HTSF) to improve the consistency of high tackle sanctioning. The HTSF is a decision-making flow chart for match officials and judicial officers to support consistent sanctioning of high tackles and guide the correct identification of high tackle severity.⁷ The HTSF was implemented at the 2019 RWC, which led to widespread awareness and intense global media precompetition focus and discussion on injury prevention during tackle.

From a socio-ecological perspective, how an injury prevention initiative is perceived by the sport's stakeholders (eg, players, coaches, referees, spectators) drives the social environment and culture around it.¹⁰⁻¹⁴ An injury prevention initiative negatively perceived by its stakeholders may reduce player, coach and referee adoption and compliance, ultimately reducing its effectiveness. To date, player and rugby stakeholder attitudes and perceptions of injury prevention initiatives have only been studied using traditional questionnaires and qualitative interviews.¹⁴⁻¹⁸

In the current digital age, social media platforms, such as X (formerly Twitter), are widespread. These social media platforms consist of large networks of users that share, communicate and engage information rapidly and cost-effectively.^{19,20} In sports, social media platforms may

be considered a primary source of information.²¹ The information communicated on these social media platforms is, for the most part, personal perspectives, views and opinions. The dynamic nature of the social network also means that users' perspectives, views and opinions can influence other users in the network while also being the subject of influence.²² Based on this widespread use, content and influence, social media can serve as a proxy to understand the current culture around a topic.²² The study of social media content to understand the culture of public health issues is well-recognised.²³ Social media content has been studied in sports to understand head injury and concussion culture.^{22, 24-26} For example, Sullivan *et al* studied X traffic over 7 days using eight concussion-related search terms.²⁵ The authors identified 3488 posts, and 1000 were randomly selected to determine major content themes.²⁵ The most frequent theme was 'news' (33%), followed by 'sharing personal information/situation' (27%) and 'inferred management' (13%).²⁵ Beyond understanding, social media can also create awareness and inform and promote injury prevention initiatives and safety in sports.²⁷

Given X's dynamic, interconnected and expressive nature and the high profile of the RWC, understanding the social media response to referee decision-making may provide insight into the culture around player welfare initiatives in rugby. Therefore, the primary aim of this study was to analyse the sentiments expressed in posts on the referee's decision to issue a red or yellow card for a tackle during the 2019 RWC. A secondary aim was to relate X activity to referee decisions (red cards and yellow cards), injuries (all injuries and tackle injuries) and tackle performance (total number of tackles per match) over the 45-match playing schedule.

METHODS

Tackle-related posts concerning foul play decisions during the 2019 RWC were collected and analysed using sentiment analysis. Sentiment analysis is a method used to classify attitudes, opinions, views and emotions from text expressed in social media posts.²⁸⁻³⁰ During sentiment analysis, the attitudes, opinions, views and emotions expressed via posts were classified into 'positive', 'negative' or 'neutral' categories.²⁸⁻³⁰

Using the social media monitoring tool TweetBinder (TweetBinder, Spain), English-only posts containing the hashtag '#RWC2019' were collected between September 9 (2019) and November 18 (2019) (2 weeks after the final match). In total, 756 657 posts were identified. For each posts, TweetBinder provides the post's text, time and date, the number of shares (reposts) and whether the post is an original post or repost. These data were subsequently exported to an Excel sheet for further analysis.

The 756 657 posts were further filtered to include only those that contained the terms 'tackle', 'tackles', 'tackling' or 'tackled' (figure 1). Based on this filter, 3182 original #RWC2019 were identified as tackle-related posts. From the sample of 3182 tackle-related posts, posts

English-only posts containing the hashtag '#RWC2019' were collected between September 9 (2019) and November 18 (2019) (two weeks after the final match)

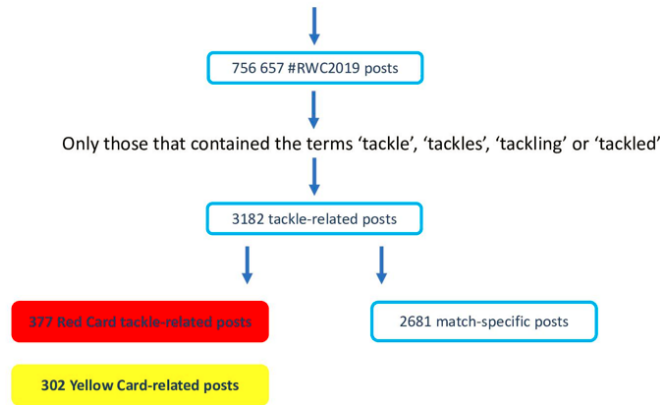


Figure 1 Outline for identifying posts. RWC, Rugby World Cup.

specific to red and yellow card referee decisions were extracted for sentiment analysis. The filters for the posts were applied in consideration of the magnitude of posts on X and to reduce the uncertainty in what the content of the post relates to. Yellow and red card data for tackle-related and non-tackle-related events were retrieved from World Rugby’s website (www.world.rugby).

To link the post data with match behaviours and illustrate the change in post frequency over the tournament, the 3182 posts were synced to the 45-match playing schedule of the tournament. The frequency of posts, red cards, yellow cards, all injuries, tackle injuries and total number of tackles per match were also synced to

the 45-match playing schedule of the tournament. The total number of tackles per match was obtained via World Rugby’s website, and match injury data were obtained from World Rugby’s Injury Surveillance Study.³

Given the HTSF referee decision-making framework implemented before the 2019 RWC (figure 2), sentiment analysis was conducted on posts related to referee decisions to issue a red or yellow card. Within the sample of 3182 tackle-related posts, text specific to the match in which the card was issued was identified. After that, posts were classified as ‘agree’ when attitudes, opinions, views and emotions supported/agreed with the referee decision, ‘disagree’ when attitudes, opinions, views and emotions opposed/disagreed with the referee decision and ‘neutral’ when the sentiments did not provide any position on the referee decision, but still offered a general comment on the tackle or referee decision. The total number of times each post within each classification (agree, disagree and neutral) received a repost (shared) and ‘likes’ were also recorded. The sum of reposts for all three classifications was then totalled to represent the total number of reposts. Likewise, the sum of ‘likes’ for all three classifications was totalled to represent the total number of ‘likes’. Posts were also identified where the attitudes, opinions, views and emotions were that the referee should have issued a card for a particular tackle.

Data are reported as totals and proportions (percentages, %). Sentiment analysis proportions between ‘agree’ and ‘disagree’ were compared using STATA Test of Proportions, with an a priori alpha significance level set at $p < 0.05$.

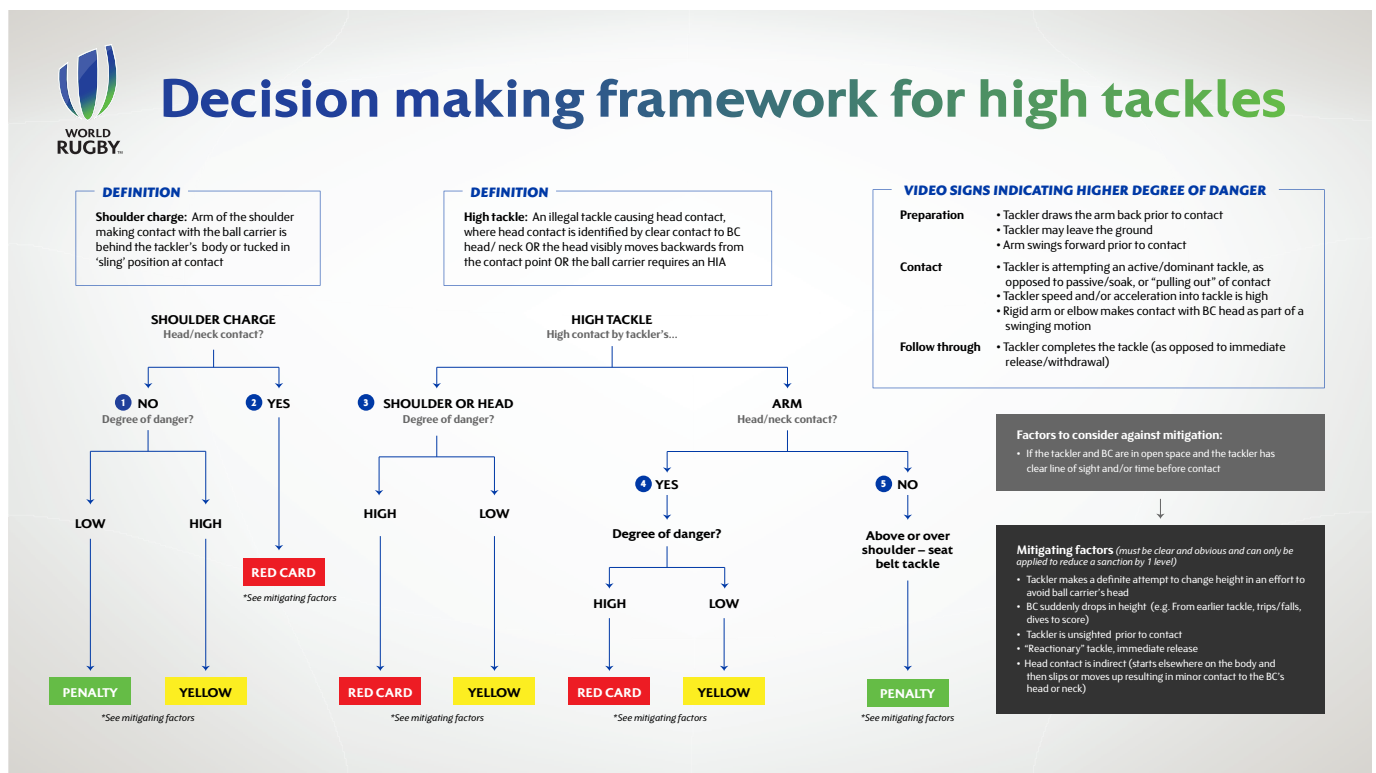


Figure 2 2019 World Rugby decision-making framework for high tackles. BC, ball carrier; HIA, head injury assessment.

**Table 1** Tackle-related and non-tackle-related yellow cards during the 2019 and 2015 Rugby World Cup

Rugby World Cup		Yellow	Red
2019	Tackle-related	15	5
	Non-tackle-related	14	3
	Total	29	8
2015	Tackle-related	12	0
	Non-tackle-related	41	1
	Total	53	1

RESULTS

Tackle-related red and yellow cards

Five tackle-related red cards were issued during the 2019 RWC, compared with none awarded for illegal tackles at the 2015 RWC (table 1). Fifteen tackle-related yellow cards were issued during the 2019 RWC, a 25% increase compared with 2015 RWC (table 1).

Red card tackle-related posts

From the sample of 3182 tackle-related posts, 377 posts shared sentiments related to red cards. Of these 377 red card tackle-related posts, 158 (42%) expressed agreement or support for the referee's decision, while 71 (19%) disagreed and 148 (39%) were neutral (table 2). For red cards, sentiments expressed in posts were 2.2 times (42/19) more likely to 'agree' with the referee's decision than disagree ($p<0.001$). Posts related to red card decisions were reposted a total of 502 times. Those that were in agreement with the red cards were reposted 316 times (63% of all reposts), which was more frequent than posts that disagreed with a red card decision (14 reposts, 3%) ($p<0.001$), and those that were neutral (172 reposted, 34%).

Yellow card tackle-related posts

A total of 302 posts were related to yellow-carded tackles. Of these, 73 (24%) agreed with the referee's decision, while 99 (33%) disagreed and 130 (43%) were neutral. Posts related to yellow card decisions were reposted a total

of 178 times (table 2). Those that were in agreement with yellow cards were reposted 42 times (24% of all reposts), which was less frequent than posts that disagreed with a yellow card decision (71 reposts, 40%) ($p<0.001$), and those that were neutral (172 reposts, 34%). Thirty-two posts were identified in three matches where X followers expressed sentiments that the referee should have issued a yellow card for a particular tackle when no card was given.

The rate of reposts was higher for red cards than for yellow cards (1.3 vs 5.9 reposts per a post). Also, red card agreement posts were significantly more likely to be reposted than yellow card agreement posts (63% vs 24%, $p<0.001$). In contrast, red card disagreement posts were significantly less likely to be reposted than yellow card disagreement posts (3% vs 40%, $p<0.001$). Examples of red and yellow card posts can be found in tables 3 and 4, respectively.

Figure 2 illustrates each tackle-related red and yellow card (and non-tackle-specific cards) by match number, along with the total number of posts, number of all tackle-related injuries and tackles per match. Total 143 injuries occurred during the tournament, with 48% tackle-related. Tackle injuries were highest in matches 9, 11, 17 and 23. The tackler sustained 60% of the tackle-event injuries, while the ball carrier sustained the remaining 40%. On average, 255 tackles (95% CI 244 to 267) occurred during a match. The maximum number of posts per match was 280.

DISCUSSION

The primary aim of this study was to analyse sentiments expressed in posts on X on referee decisions to issue a red or yellow card for a dangerous or illegal tackle during the 2019 RWC. For red cards, sentiments expressed in posts were 2.2 times more likely to agree with the referee's decision than disagree. Posts related to red cards were more likely to be reposted than posts related to yellow cards. Within the red card posts, those that agreed with a referee red card decision were more likely to be shared widely within the network than posts that disagreed with the decision. From a player welfare

Table 2 Proportions of 'agree', 'disagree' and 'neutral' for post content, reposts and likes for red cards and yellow cards

	Agree (%)	Disagree (%)	Neutral (%)	Agree versus disagree
Red cards				
Post content (n=377)	42	19	40	P<0.001
Total reposts (n=502)	63	3	34	P<0.001
Total likes (n=2528)	47	5	48	
Yellow cards				
Post content (n=302)	24	33	43	P=0.199
Total reposts (n=178)	24	40	37	P<0.01
Total likes (n=932)	12	32	55	

Table 3 Examples of posts that were identified as ‘agreed’, ‘disagreed’ and ‘neutral’ with a red card decision

Red cards	Example posts
Agreed	Quill deserves that, awful tackle. #ENGvUSA #RWC2019
	That was a ridiculous tackle on Vermeulen. Clean turnover then dumped on his head. Red card coming for sure. #RSAvITA #RWC2019 @ecr9495 @Hollywoodbets
	That's a red. You can say Farrell is dipping but look at the body angle of the tackler. He was always going high. You just can't do it. #RugbyUnited #RWC2019 p.s. don't forget the clever play by May. Marking that ball knowing it stops play and TMO has a look
	As much as I'm not a fan of red cards for tackles... The red given to Canada'a Larsen was 100% right. Deserves a lengthy ban #RWC2019
	As gutted as I am that is absolutely the right call. Well done ref. #RWC2019 #IREvSAM gutted gutted gutted. But players HAVE to take responsibility. Get lower or miss the tackle!!
	Wow what a stupid tackle, definitely a red #RWC2019
Neutral	Hodge ‘unaware’ of new high tackle rules, says disciplinary panel #RWC2019 https://t.co/rfZhg8Rabh
	That was an unnecessary tackle by the #19 #RWC2019
	Players have to look at their tackle technique before the game is ruined by red cards. #ENGvARG #RWC2019
	Argentina down to 14 as Tomas Lavanini is sent off for a high tackle on Owen Farrell.
	The right call? #RWC2019
	https://t.co/1sryf9zt4l RED CARD! Bundee Aki is sent off for a high tackle! Harsh? #RWC2019
Disagreed	THAT'S BULLSHIT. Ball was lost before contact. 11 had nothing to do with it. If anything he was pulling out of a tackle thinking try was scored. Seriously shit decision. Worst one of the tournament so far #SCOvSAM #RWC2019
	Poor by Nigel Owens. At most that was a yellow. The no hands tackle on the try line on England wasn't given as a yellow. Poor. #RWC2019
	This game is bullshite. @WorldRugby has fumes up the game . Not interested in the battle anymore or watching this. The tackle has gone the scrum had gone. Ridiculous red card for Argentina #ENGvARG #RWC2019 #bullshite #fucked
	What a joke of a decision. These f***** refs are a disgrace #RWC2019. He fell into the tackle. Disgrace
	The player sent of is 6 foot fucking 8. He's gotten low. Farrell is going down. Red card is an absolute joke. What next? Any tackle above the ankles will be a f***** refs penalty soon. #RWC2019
	F** ME.....World #Rugby is a shit show...An Argentinian player just got Red Carded for a nothing tackle.... Bringing your best players to RugbyLeague #ENGvARG #RWC2019

TMO, television match official.

perspective, considering the increase in the number of tackle-related red cards compared with previous RWCs,³¹ the agreement and sharing of the referee decision demonstrates an intolerance towards clear and obvious illegal or dangerous play.

In contrast, sentiments expressed for yellow cards were mixed. Also, disagreeing with the referee received more shares than agreeing with the referee. Explaining these differences requires an understanding of how the 2019 HTSF produces the outcome of either yellow or red cards. A red card for a high tackle would result from a very distinct set of decisions, which would, by definition, include interpreting a tackle as having a

high degree of danger and deciding that no mitigating factors should be applied to reduce the sanction level. In contrast, a yellow card would be the outcome if the referee decides that the degree of danger is low and no mitigation should apply or if the degree of danger is high but mitigation does apply.^{7 32} Finally, a penalty can be awarded if the degree of danger is assessed as low and mitigation is deemed to apply. The process thus relies on two decisions in which interpretation and a degree of subjectivity are required, and a red card decision is thus the result of only one possible pairing of decisions within the process. In contrast, a yellow card decision can be reached in two ways. Interpreting the degree of danger

Table 4 Examples of posts that were identified as ‘agreed’, ‘disagreed’ and ‘neutral’ with a yellow card decision

Yellow cards	Example posts
Agreed	Perfect work from Romain Poite the TMO, yellow card the right call.
	It's good to see the high tackle process being implemented properly (at last!) in #RWC2019 #RUSvSAM
	Another yellow card for Australia!
	Correct decision.
	Teach these dummies how to tackle. #RWC2019 #AUSvURU
	Great decision Mr Berry. Mitigating factors with player dropping as the tackle is made. Yellow. Ab-so-lute-ly. #IREvSAM #RWC2019
	Seriously - what the F is wrong with our tackle technique???? 2nd high in 2 mins. Coleman is getting a rest #YellowCard #AUSvURU #RWC2019 #GoldBlooded 13'
	I don't get pundits & commentators complain about the referee. #AUSvGEO #GEOvAUS in #RWC2019 tackle was a shot to the head. It's a clear directive to stay below the neck. Legit yellow card. No issues.
Neutral	Swinging arm around the neck. Yellow card for Nepo Laulala. He'll be relieved it wasn't red. So difficult these days... tackler was falling. #NZLvNAM #RWC2019 https://t.co/FTLUcP8y2K
	How to win the #RWC2019 : Just fall before every tackle it will result in a yellow card for the tackler...
	Nearly 30 minutes gone and #Samoa trail Russia 5–6 at #RWC2019. Samoa centre receives #yellowcard for a high tackle https://t.co/rVppp4hfgj
	Rugby has a real problem... If you have the ball, it's better for you to jump into and or fall into tackles and you will get a Penalty/Yellow Card/Red Card just by a player trying make a tackle #RWC2019 https://t.co/5BESIsK1ff
	If the tackler is so low, any lower would be sitting on the ground, should it really be a yellow card for a head high? The framework should include common sense! #RWC2019 https://t.co/3OXEJShVfV
Disagreed	I don't think that tackle was deserving of even a yellow, let alone consideration of a red. The only contact with the head was as a result of the Russian player's neck movement after the initial hit #RussiaSamoa #RWC2019
	That was a yellow!? This directive of high tackles as it stands is bullshit. Awful refereeing #NZvNam #RWC2019
	Do not agree with that yellow card, a low tackle on a fast running player he is going to flip! #WALvFIJ #RWC2019
	Ridiculous yellow card. Attacking player drops into the tackle, defensive player is clearly trying to make a legitimate tackle crouching down. What can he do?? #RWC2019
	Some of these yellow cards for tackles in the #RWC2019 are a f***** joke itll be touch rugby soon #RWC2019 absolutely ridiculous referee call. How can it be a high tackle if the ball carrying player falls down into the tackle?!?!?? Madness with a yellow card!!

TMO, television match official.

as low was guided in the HTSF by several identified video signs. For example, the low danger was assessed when the tackler's speed was low rather than high, when the tackle was passive rather than dominant and when the tackler applied less force in the contact.^{7 32} Concerning mitigation, the HTSF provided a list of five factors that referees could consider to mitigate a sanction down from red card to yellow card or from yellow card to penalty. These included late changes in height by the ball carrier, indirect contact to the head and a tackler who was unsighted before contact. As with the degree of danger, a degree of

subjective interpretation was required by match officials to decide whether or not mitigation should apply.

As a result of this subjective interpretation, decisions reached by different assessors may differ. They may also be confounded by several factors—time of the match, a close scoreline difference between teams, the presence of fans or the use of the television match official (TMO) itself.^{33–35} The greater agreement reflected in our X sentiment analysis may result from how observers judge the degree of danger and mitigation in red-carded tackles compared with yellow-carded tackles. It is notable that (a)

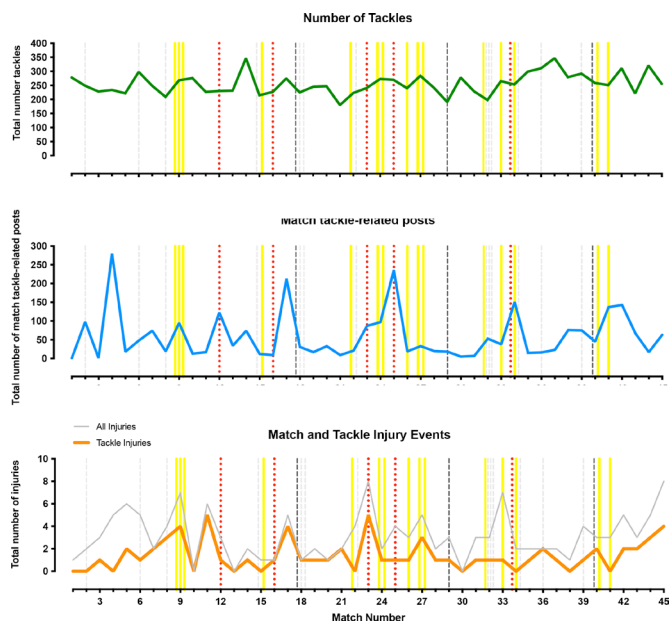


Figure 3 The total number of tackles, match tackle-related posts, match injury events and tackle-related red cards (red-dotted line) and yellow cards (yellow line) for each match during the 2019 Rugby World Cup. Other red cards (dark-grey dash) and yellow cards (light-grey dash) are also shown.

red cards are less frequently awarded than yellow cards (5 vs 15 in the present cohort) and (b) yellow cards can be disagreed with on the basis that they are either too harsh or too lenient because of how the degree of danger and mitigation may be applied in series. That is, one observer may assess a yellow-carded tackle as too harsh because they feel that the combination of degree of danger and mitigation have been too strictly applied. In contrast, a different observer may assess a yellow card as too lenient. After all, they feel that the tackle was more dangerous or that mitigation should not have been applied.

In contrast, red card disagreements may only arise because a decision is thought of as too harsh when an observer feels that the match officials should either have applied mitigation but did not, or, that the degree of danger was low rather than the high. Since red cards are relatively rarer than yellow cards, it seems logical to suggest that match officials, reluctant to send players from the field unfairly, are more likely to issue red cards only when they are very confident that both danger is high and that mitigation is absent, and this is likely the reason for broader agreement with red card decisions than yellow card decisions.

From a player welfare perspective, arguably, the above discussion points highlight that issuing yellow cards and using the TMO can be reframed as a potential opportunity to create more awareness and learning around tackle safety. Within the ecosystem of sport, particularly rugby, sharing attitudes, opinions, views and emotions on social media plays a powerful role in creating a positive player welfare narrative. Given the priority to reduce head injury and impact through stricter sanctioning of

high-risk tackles, most spectator sentiments expressed on social media platforms like X are related to referee decision-making—especially the issuing of cards, which could influence the outcome of matches. While 100% agreement between referees and spectators may never be attainable, the proportion of posts that agreed with the referee's decision to issue red cards compared with yellow cards and the sharing of these sentiments suggests that changing the culture within the sport is possible, since observers engaged more positively than negatively with red card decisions. For yellow cards, decision-making consistency is the challenge⁷ as a low degree of danger or mitigation application for a tackle is subjective, more complex and may be influenced by conscious and unconscious bias.³³

The question is how platforms such as X can help interpret yellow-carded tackle scenarios. Outside of sports, social media campaigns to deliver injury prevention messages have shown promise in shaping online conversations about the injury.²⁷ World Rugby provided a range of resources to explain the HTSF before the 2019 RWC via social media and their website (although the impact of this campaign was not measured). The HTSF has also evolved since the 2019 RWC and is now called the Head Contact Process, which has been expanded to apply to the ruck event and tackle.³² Having said that, a potential avenue to create further awareness and understanding is an official postmatch analysis on X with the match-day officials, coaches, players and spectators present, where the referees explain their decision-making process. Indeed, access and understanding of the on-field and referee decision-making process improves fans' appreciation of the decision and how it was derived.³⁵ One of X's more recent features, such as 'community' or 'spaces', can be used to host such an initiative. The point of the initiative is to learn and understand the decision-making process and not to criticise or debate the actual decision. World Rugby conducts this process after every match to evaluate the referees and the application of the laws. However, this is conducted confidentially. Conceivably, a version of this process can be held on a public platform like X.

A unique strength of this study is that it assessed the social media response, a proxy for culture, to a new player welfare initiative implemented just before a single international tournament. With that said, the sentiment analysis approach used in this study was the manual classification of posts, which can be considered a strength and a limitation. Manually classifying posts can be considered a limitation because it is exposed to subjectivity. Manually classifying posts however can also be considered a strength as it allows for the recognition of nuance and specificity within the text compared with automated sentiment analysis software, which is typically used in consumer research.³⁶ Our analyses were also limited to polarised categories. While this is the basic form of sentiment analysis, future analyses should go a step further and identify themes as to why the public 'disagreed' with a referee's



decision. The study was also limited to users of one social media platform and English-only posts containing the hashtag #RWC2019. As such, caution should be applied when generalising these findings. Also, while the filters were applied in consideration of the magnitude of posts on X and to reduce the uncertainty in what the content of the post relates to, we acknowledge that this filtering may have excluded some posts, for example, a tackle-related post without #RWC2019.

The study also represents a line of work that future sports injury prevention studies can build off from to evaluate the culture around a new safety initiative and/or policy. The study approach can also be used to study the evolution of safety initiatives. For example, notable decisions by World Rugby to remove head impacts from the game began in 2016 and evolved over the last 7 years, specifically at the elite level. Therefore, sentiment analysis of elite club competitions from 2016 to the present will provide an extended study period to determine whether rugby's tackle safety culture has shifted. Furthermore, detailed video analysis of the tackles by independent referees and analysts, in combination with the sentiment analysis, could provide further insights into tackle safety.

CONCLUSION

For red cards, sentiments expressed in posts were 2.2 times more likely to 'agree' with the referee's decision than disagree. This agreement with a referee red card decision was also shared widely within the network while disagreeing was not shared as widely. In contrast, views and opinions expressed for yellow cards were mixed, which may be related to interpreting the degree of danger and whether mitigation applied. While full agreement between spectator sentiments and the referee may never be attainable, the proportion of posts that agreed with the referee's decision to issue red cards compared with yellow cards and the sharing of these sentiments suggests that changing the culture within the sport is possible. Within the ecosystem of rugby, sharing sentiments on social media plays a powerful role in creating a positive player welfare narrative. Governing bodies can leverage this through social media strategies that create awareness and understanding of referee decision-making.

Author affiliations

¹Division of Physiological Sciences and Health through Physical Activity, Lifestyle and Sport Research Centre, Department of Human Biology, Faculty of Health Sciences, University of Cape Town, University of Cape Town, Cape Town, Western Cape, South Africa

²World Rugby Limited, Dublin, Ireland

³Institute of Sport and Exercise Medicine, Stellenbosch University, Cape Town, South Africa

⁴Carnegie Applied Rugby Research (CARR) Centre, Carnegie School of Sport, Leeds Beckett University, Leeds, UK

⁵Premiership Rugby, London, UK

⁶England Performance Unit, Rugby Football League, Manchester, UK

⁷School of Behavioural and Health Sciences, Australian Catholic University, Sydney, New South Wales, Australia

Twitter Ben Jones @23benjones and Sharief Hendricks @Sharief_H

Acknowledgements We would like to thank Colin Fuller for access to the 2019 Rugby World Cup tackle injury data.

Contributors FA and SH designed the study, collected the data and analysed it. SH wrote the first draft of the manuscript. RT and BJ provided substantial input and edits. All authors reviewed the final version of the manuscript. All authors are responsible for the overall content as guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests RT is a consultant for World Rugby.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was approved by the University of Cape Town Faculty of Health Sciences Human Research Ethics Committee (HREC 702/2023).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Ben Jones <http://orcid.org/0000-0002-4274-6236>

Sharief Hendricks <http://orcid.org/0000-0002-3416-6266>

REFERENCES

- World Rugby. *World Rugby year in review 2021*. 2021: 10–1.
- Fuller CW, Laborde F, Leather RJ, et al. International Rugby board Rugby world cup 2007 injury surveillance study. *Br J Sports Med* 2008;42:452–9.
- Fuller C, Taylor A, Douglas M, et al. Rugby world cup 2019 injury surveillance study. *S Afr J Sports Med* 2020;32:1–6.
- Fuller CW, Sheerin K, Targett S. Rugby world cup 2011: International Rugby board injury surveillance study. *Br J Sports Med* 2013;47:1184–91.
- Fuller CW, Taylor A, Kemp SPT, et al. Rugby world cup 2015: world Rugby injury surveillance study. *Br J Sports Med* 2017;51:51–7.
- Daneshvar DH, Riley DO, Nowinski CJ, et al. Long-term consequences: effects on normal development profile after concussion. *Phys Med Rehabil Clin N Am* 2011;22:683–700.
- Rafferty M, Tucker R, Falvey EC. Getting tough on concussion: how welfare-driven law change may improve player safety—a Rugby Union experience. *Br J Sports Med* 2021;55:527–9.
- Cross MJ, Tucker R, Rafferty M, et al. Tackling concussion in professional Rugby Union: a case-control study of tackle-based risk factors and recommendations for primary prevention. *Br J Sports Med* 2019;53:1021–5.
- Tucker R, Rafferty M, Kemp S, et al. Risk factors for head injury events in professional Rugby Union: a video analysis of 464 head injury events to inform proposed injury prevention strategies. *Br J Sports Med* 2017;51:1152–7.
- Finch CF. No longer lost in translation: the art and science of sports injury prevention implementation research. *British Journal of Sports Medicine* 2011;45:1253–7.
- Finch CF, Donaldson A. A sports setting matrix for understanding the implementation context for community sport. *Br J Sports Med* 2010;44:973–8.
- Hendricks S, Emery C, Jones B, et al. Tackling Rugby safety through a collective approach. *Br J Sports Med* 2023;57:562–3.
- Keats MR, Emery CA, Finch CF. Are we having fun yet? Fostering adherence to injury preventive exercise recommendations in young athletes. *Sports Med* 2012;42:175–84.
- Hulme A, Finch CF. From monocausality to systems thinking: a complementary and alternative conceptual approach for better understanding the development and prevention of sports injury. *Inj Epidemiol* 2015;2:31:31..
- Hendricks S, Sarembock M, Jones B, et al. The tackle in youth Rugby Union – gap between coaches' knowledge and training behaviour. *International Journal of Sports Science & Coaching* 2017;12:708–15.

- 16 Hendricks S, Jordaan E, Lambert M. Attitude and behaviour of Junior Rugby Union players towards tackling during training and match play. *Safety Science* 2012;50:266–84.
- 17 Brown JC, Verhagen E, van Mechelen W, et al. Coaches' and referees' perceptions of the BokSmart injury prevention programme. *International Journal of Sports Science & Coaching* 2016;11:637–47.
- 18 Barden C, Watkins R, Stokes KA, et al. Barriers and facilitators to implementing the activate injury prevention exercise programme—a qualitative study of schoolboy Rugby coaches. *International Journal of Sports Science & Coaching* 2022;17:1317–30.
- 19 Erskine N, Hendricks S. The use of Twitter by medical journals: systematic review of the literature. *J Med Internet Res* 2021;23:e26378.
- 20 Hendricks S, Jones A. European Journal of sport science gears up its social media. *Eur J Sport Sci* 2014;14:519–20.
- 21 Hull K, Schmittel A. A fumbled opportunity? A case study of Twitter's role in concussion awareness opportunities during the super bowl. *Journal of Sport and Social Issues* 2015;39:78–94.
- 22 Workewych AM, Ciuffetelli Muzzi M, Jing R, et al. Twitter and traumatic brain injury: A content and sentiment analysis of Tweets pertaining to sport-related brain injury. *SAGE Open Med* 2017;5:2050312117720057.
- 23 Giustini DM, Ali SM, Fraser M, et al. Effective uses of social media in public health and medicine: a systematic review of systematic reviews. *OJPHI* 2018;10.
- 24 Ahmed OH, Lee H, Struik LL. A picture tells a thousand words: a content analysis of concussion-related images online. *Phys Ther Sport* 2016;21:82–6.
- 25 Sullivan SJ, Schneiders AG, Cheang C-W, et al. What's happening?'A content analysis of concussion-related traffic on Twitter. *Br J Sports Med* 2012;46:258–63.
- 26 Williams D, Sullivan SJ, Schneiders AG, et al. Big hits on the small screen: an evaluation of concussion-related videos on Youtube. *Br J Sports Med* 2014;48:107–11.
- 27 Zazzera E. Use of social media for injury prevention: an integrative review. *J Trauma Nurs* 2020;27:13–28.
- 28 Alsaeedi A, Zubair M. A study on sentiment analysis techniques of Twitter data. *Ijacsa* 2019;10:361–74.
- 29 Kharde V, Sonawane P. Sentiment analysis of Twitter data: a survey of techniques. *arXiv Preprint arXiv* 2016:160106971 2016.
- 30 Mäntylä MV, Graziotin D, Kuuttila M. The evolution of sentiment analysis—a review of research topics, venues, and top cited papers. *Computer Science Review* 2018;27:16–32.
- 31 World Rugby. *Rugby World Cup 2019 statistical report*. 2020.
- 32 World Rugby Rugby. *Law application guidelines*.
- 33 Dawson P, Massey P, Downward P. Television match officials, referees, and home advantage: evidence from the European Rugby cup. *Sport Management Review* 2020;23:443–54.
- 34 Page L, Page K. Evidence of referees' national Favouritism in Rugby. NCER Working Paper Series 62; National Centre for Econometric Research, 2010
- 35 Stoney E, Fletcher T. Are fans in the stands an afterthought?": sports events, decision-aid technologies, and the television match official in Rugby Union. *Communication & Sport* 2021;9:1008–29.
- 36 Gohil S, Vuik S, Darzi A. Sentiment analysis of health care tweets: review of the methods used. *JMIR Public Health Surveill* 2018;4:e43.