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Concussion-Reporting Behavior in Rugby

A National Survey of Rugby Union Players in the United States

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Investigation performed at the Vagelos College of Physicians and Surgeons, Columbia University, New York, New York, USA

Background: Rugby is the fastest growing team sport in the United States for male and female athletes. It is a contact/collision sport with an injury risk profile that includes concussions.

Purpose: To examine the prevalence of concussions in male and female rugby players in the United States and to characterize behaviors around reporting concussions that could be a target for prevention and treatment efforts.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: An online survey distributed to active members on the USA Rugby membership list was used to examine self-reported concussions in male and female athletes. Concussion-reporting behaviors and return to play after a concussion were also explored. Statistical analysis was used to compare male with female athletes and report differences, with years of experience as a dependent variable.

Results: The proportion of athletes with a history of at least 1 concussion was 61.9% in all respondents. Of those who reported a concussion, 50.8% reported the concussion during the game or practice in which it occurred, and 57.6% reported at least 1 concussion to a qualified medical provider. Overall, 27.7% of participants who reported ≥ 1 rugby-related concussion in our survey noted that at least 1 of these concussions was not formally reported. The most commonly cited reasons for not reporting a concussion included not thinking that it was a serious injury, not knowing that it was a concussion at the time, and not wanting to be pulled out of the game or practice. Additionally, 61.0% of athletes did not engage in recommended return-to-play protocols after their most recent rugby-related concussion.

Conclusion: US rugby union athletes may not report concussions to medical personnel or follow return-to-play protocols guided by medical advice. This could result from a lack of education on concussion recognition and the risks associated with continued play after a concussion as well as limited access to health care. Further education efforts focusing on the identification of concussions, removal from play, and return-to-play protocols are necessary in the US rugby union population.

Keywords: head injuries/concussion; rugby; concussion reporting

Rugby union is a popular contact/collision sport played around the world, with 7.23 million participants in 120 countries.⁴⁷ The sport has benefited from a rapid growth in participation and spectator popularity in the United States, with World Rugby estimating 1.45 million players participating and USA Rugby, the official governing body of rugby in the United States, reporting over 115,000 active registered players.^{46,50} A 2014 report by the Sports and Fitness Industry Association noted rugby had the highest 5-year annual average growth rate of any team sport in the United States (13.8%).⁴³

A concussion is an injury to the brain, typically sustained from a direct or indirect blow to the head.³¹ It is one of the more common injury risks associated with playing rugby. Several articles have characterized the epidemiologic data of rugby injuries in the United States. Collins et al¹⁰ investigated injury rates in US high school rugby. Their reported injury rate was 15.2 injuries per 1000 match exposures; 21.7% of injuries were to the head, and 15.8% of all injuries were diagnosed as concussions. There was no difference in head injury rates between matches and practices.¹⁰ Kerr et al²³ reported an injury rate of 16.88 per 1000 match exposures and 5.52 per 1000 practice exposures for all players on 31 men's and 38 women's US collegiate rugby union teams. Head injuries made up 27.1% of match injuries and 20% of practice injuries, while concussions made

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up 12.7% of match injuries and 6.7% of practice injuries; however, Kerr et al²³ noted that the diagnosis of a concussion in many cases was not made by a health care professional. Peck et al³⁴ investigated injury rates in collegiate male and female rugby athletes. Their study reported injury rates of 3.77 per 1000 total exposures in male athletes and 2.91 per 1000 total exposures in female athletes. A concussion was the most common injury in female athletes and the second most common in male athletes (15% and 8.7%, respectively).³⁴ One meta-analysis of 96 studies found an overall incidence of 4.73 concussions per 1000 player match hours across all levels, with the greatest rates at the subelite level.¹⁷ Another analysis of 25 primary studies on concussion rates in youth rugby found the probability of a concussion after 1 season of ≥ 15 matches was 0.3% to 11.4% in rugby union and 7.7% to 22.7% in rugby league.²⁷ A concussion in rugby remains a concern¹⁷ and a priority area for player welfare.⁵¹

Concussions have come under recent scrutiny in contact/collision sports including rugby because of links between repetitive head trauma and long-term neurological sequelae.⁴² The link between concussions in contact sports, particularly American football, and long-term brain injuries has been frequently studied, and there has been a great deal of media attention on the topic since the acknowledgment that there may be a link between American football and chronic traumatic encephalopathy.^{21,33,38} American football has a notoriously high rate of concussions, with a recent study noting the game concussion rate is 2.01 per 1000 athlete exposures for high school athletes and 3.74 per 1000 athlete exposures for college athletes.¹³ Although rugby union has not been studied as frequently as American football in the United States, a study directly comparing concussion rates between the 2 at the collegiate level described the overall incidence of both head injuries and concussions as greater for rugby than American football.⁴⁹ Additionally, multiple recent meta-analyses have found the greatest incidence of concussions in rugby matches in both youth³⁷ and elite³⁹ levels of play compared with similar levels of soccer, ice hockey, and American football.

With the continued growth of rugby in the United States, an understanding of the unique, complex characteristics of the US rugby union population would be of benefit to rugby players and the medical community. Furthermore, understanding the timing of concussion reporting, persons to whom concussions are reported, and barriers to reporting

could help to target prevention and awareness efforts. A large-scale comprehensive study examining these factors in US rugby union players has yet to be performed.

The purpose of this study was to estimate the lifetime prevalence of self-reported concussions in rugby union players in the United States including both those formally diagnosed by a medical professional and those “self-diagnosed.” Furthermore, we sought to estimate the frequency of undiagnosed concussions, determine to whom concussions were most frequently reported, and identify reporting behaviors that could increase the risk of concussions going undiagnosed and potentially increasing the risk of more serious injuries. We hypothesized that concussion reporting would be lacking in rugby athletes and would be limited by both a recognition of the injury and an understanding of injury severity.

METHODS

This cross-sectional study was designed to characterize the demographics of athletes ≥ 15 years in US rugby union, identify the percentage of these players who reported having sustained a concussion, and note behaviors around reporting concussions that could be a target for prevention and treatment efforts. A newly developed online multiple-choice survey was used to collect demographic and concussion data from respondents (see the Appendix). This survey was modeled on the survey developed in collaboration with Rugby Football Union medical staff and utilized by both Brooks et al^{5,6} and Kerr et al²³ in studies on rugby injury patterns. The survey platform (Qualtrics) was used to conduct an email-solicited survey. Study participants were asked to use the following definition for a concussion, which was based on the consensus statement on concussion in sport from the 5th International Conference on Concussion in Sport³¹ as well as expert opinions:

A concussion is a blow to the head followed by a variety of symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, “seeing stars,” feeling in a fog or slowed down, memory problems, poor concentration, nausea, or throwing-up. Getting “knocked out” or being unconscious does NOT always occur with a concussion.³¹

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Ethical approval for this study was obtained from Columbia University (protocol No. AAAR4125).

Based on this definition, respondents were asked a series of questions about concussions. Questions included demographic information, frequency of rugby-related and non-rugby-related concussions, concussion-reporting behavior, use of return-to-play protocols, time away from play after a rugby-related concussion, and mechanism of injury. This study was approved by the institutional review board of Columbia University.

Study recruitment was via an email sent by USA Rugby to its members on June 13, July 3, July 20, and August 8, 2017. The email contained a link to the online questionnaire, and 3 gift cards, worth \$50 each, were raffled off during the 3 months that the survey was open. One gift card was raffled off each month, and a responder was eligible to be in the raffle after completing the questionnaire. The incentive was to complete the questionnaire quickly to be eligible for all 3 raffles. The survey links were anonymous, and a responder could potentially fill the survey out more than once if he or she used different computers (Internet Protocol address and web browser cookies) were used to prevent using the same computer twice). However, an email address was required to enter the raffle after the survey was completed, so to enter the raffle twice, a responder would have had to use different email addresses as well as different computers. Respondents were given information about the questionnaire and given the opportunity to provide informed consent before beginning the survey. After informed consent was provided, the responder proceeded to complete a voluntary survey, lasting approximately 10 minutes.

We sent the survey at the beginning of the first month as well as monthly reminders for the 2 following months, for a total of a 3-month recruitment period, after which time the survey was closed. With a population size of 115,000 based on the number of actively registered USA Rugby members, we required a minimum sample size of 1057 for a margin of error of $\pm 3\%$ at the 95% CI based on a conservative estimated selection frequency of 50% for any given answer choice. However, we did not limit the number of surveys accepted. Rather, we accepted all survey responses completed in the 3-month period before survey closure.

The study was limited to USA Rugby members who began the survey and were at least 15 years of age. A total of 2955 members met these criteria. For the purpose of our subanalysis on the number of concussions stratified by years of experience, we analyzed those athletes who had played at least most of 1 season of rugby, had from 1 to 10 years of rugby-playing experience, and answered the following question: "Do you believe you have had a concussion?"

The number of concussions sustained by athletes was also stratified by years of rugby played at the time of the survey, which was divided into 3 levels of playing experience: 1, 2 to 5, and 6 to 10 years. The data in this analysis were censored at a minimum of 1 year of playing experience (defined as having played "at least the majority of 1 season") and a maximum of 10 years of playing experience because of the low number of women in the study with greater than this amount of experience. We also selected a maximum of 10 years of experience to limit recall bias, as

agreement between self-reported and clinically documented concussions is improved when athletes have sustained the concussion within 10 years.²⁴ Years played was analyzed as an ordinal variable with 3 levels (1, 2-5, 6-10 years) for bivariate analysis. The remaining data were reported as a percentage of total respondents who selected each answer choice.

Statistical analysis was conducted using SAS Version 9.4 (SAS Institute). Univariable analysis (Proc Means) was employed to examine descriptive statistics for age, years of rugby played, age at first concussion, rugby concussions, nonrugby concussions, and total concussions. All analyses were stratified by sex. Statistical significance was defined as P values $\leq .05$.

RESULTS

The recruitment email was sent to 133,530 email addresses on the USA Rugby membership list. A total of 15,796 possible participants opened the email, and 3195 respondents clicked on the link and began the survey. We excluded 240 participants who were not at least 15 years of age, leaving 2955 who clicked the link to the survey, met the age requirement, and began the survey. This gave us a response rate of 20.2% (3195/15,796) based on the percentage of those who began the survey out of the total number of athletes who clicked on the original email. Our margin of error with a sample size of 2955 was $\pm 1.78\%$ at the 95% CI. For the purpose of our subgroup analysis of the number of concussions stratified by sex and years of experience, we excluded 202 respondents who did not play at least most of 1 season, 642 who had more than 10 years of experience, and 205 who did not answer questions about concussions sustained, leaving 1906 (64.5%) who played at least most of 1 season of rugby, had from 1 to 10 years of rugby playing experience, and answered the following question: "Do you believe you have had a concussion?" (Figure 1).

Demographic information collected on all participants is shown in Table 1. On average, male athletes responding to the survey were aged 32.7 years compared with 24.8 years for female athletes ($P < .0001$). There was also a significant difference between male and female athletes in the number of years played, with male athletes having 10.2 years of experience, on average, compared with 4.7 years for female athletes ($P < .0001$). For respondents who reported playing 15s rugby (15 players per side playing 40-minute halves), the mean number of months per year that were spent playing or practicing was 3.37, with a mean of 12.02 matches per year ($n = 2506$). For respondents who reported playing 7s rugby (7 players per side playing 7-minute halves), the mean number of months per year that were spent playing or practicing was 6.49, with a mean of 11.71 matches per year ($n = 1939$). During active training periods for both 7s and 15s rugby, respondents practiced 2.93 times per week for a duration of 2.01 hours per practice, on average ($n = 2533$).

When given the definition of a concussion including the symptom list and asked whether they believed that they had sustained a concussion, 61.9% of surveyed athletes

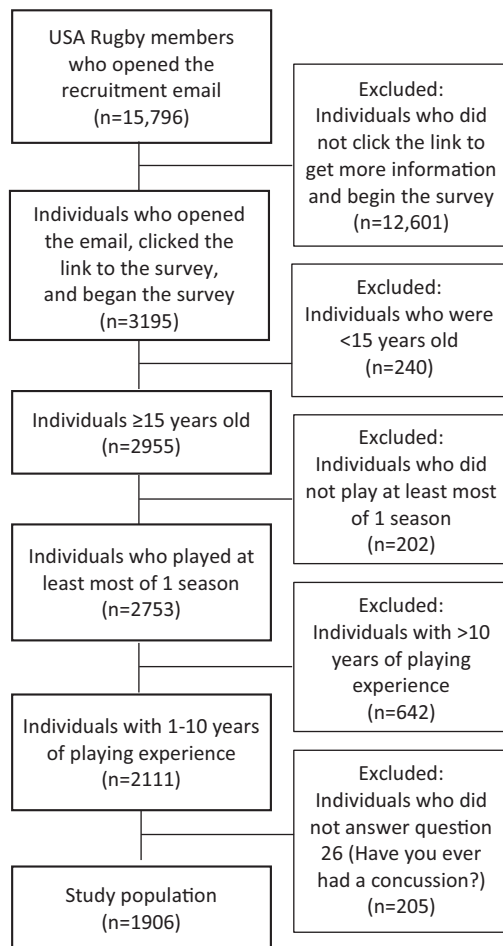


Figure 1. CONSORT (Consolidated Standards of Reporting Trials) flow diagram of respondents included and excluded in the study.

reported at least 1 rugby-related concussion, and 71.0% reported at least 1 lifetime concussion from any cause. In addition, 25.5% of those reporting ≥ 1 rugby-related concussion had sustained at least 1 concussion in practice, whereas 92.1% had sustained at least 1 of these rugby-related concussions in a match. The mean number of rugby-related concussions reported was 2.3, and the mean number of concussions sustained outside of rugby was 1.4. The results are broken down by sex in Table 2. On average, male athletes had 2.6 rugby-related concussions compared with 1.7 in female athletes ($P < .0001$). However, there was no difference in the mean age at the time of the first concussion ($P = .567$).

Table 3 shows the results for our subgroup analysis of the percentage of athletes who sustained at least 1 concussion stratified by years of experience and sex. The number of years played was significantly associated with an increased risk of having at least 1 concussion in both male and female athletes ($P < .0001$ and $P < .0001$, respectively; χ^2 test). Approximately 60% of male athletes with 2 to 5 years of playing experience had a history of at least 1 concussion, while approximately 75% of male athletes with 6 to 10 years

TABLE 1
Respondent Demographic Data at Time of Survey Completion^a

	Male (n = 1874)	Female (n = 1081)	Overall (N = 2955)
Age, y	32.7 (32.0-33.4)	24.8 (24.2-25.4)	29.8 (29.3-30.3)
No. of years played	10.2 (9.7-10.7)	4.7 (4.4-4.9)	8.2 (7.9-8.5)

^aData are presented as mean (95% CI).

TABLE 2
Number of Concussions and Age at First Concussion^a

	Male (n = 1874)	Female (n = 1081)	Overall (N = 2955)
No. of rugby-related concussions	2.6 (2.4-2.7)	1.7 (1.6-1.8)	2.3 (2.2-2.4)
No. of concussions outside of rugby	1.7 (1.6-1.9)	0.8 (0.7-0.9)	1.4 (1.3-1.5)
Age at time of first concussion, y	17.3 (16.9-17.7)	17.5 (17.1-17.8)	17.4 (17.1-17.7)

^aData are presented as mean (95% CI).

of playing experience had a history of at least 1 concussion. Among female athletes, approximately 47% in the 1-year group, 67% in the 2- to 5-year group, and 79% in the 6- to 10-year group had a history of at least 1 concussion.

The remaining questions asked about the most recent concussion sustained to simplify recall and gather information about reporting. The most commonly cited actions at the time of the injury were tackling (42.0%), being tackled (34.7%), rucking (12.4%), and other or unknown (10.9%). The most common mechanisms of injury were head to ground (26.3%), head to knee (21.7%), other or unknown (19.1%), head to head (14.9%), and head to shoulder or elbow (8.9%).

In order of decreasing frequency, concussions were most commonly reported to a coach, teammate, athletic trainer, physician, parent, and captain. These results are summarized in Figure 2. Of those who reported a concussion, only 50.8% reported the concussion during the game or practice, with 27.4% reporting the concussion immediately after the game or practice, 19.0% reporting the concussion ≥ 1 days after the game or practice, and 2.9% responding that they were uncertain of the timing of reporting. These results are summarized in Figure 3.

Overall, 27.7% of participants who reported ≥ 1 rugby-related concussion on our survey acknowledged that they did not formally report at least 1 of these concussions. In order of decreasing frequency, the most commonly cited reasons for not reporting a concussion were not thinking that it was serious enough, not knowing that it was a

TABLE 3
Concussions by Number of Years Played in Athletes With 1-10 Years of Experience^a

No. of years played	Male (n = 1048)			Female (n = 858)		
	Concussion	No Concussion	P Value	Concussion	No Concussion	P Value
1	10 (76.92)	3 (23.08)	<.0001	23 (46.94)	26 (53.06)	<.0001
2-5	390 (59.63)	264 (40.37)		441 (67.02)	217 (32.98)	
6-10	284 (74.54)	97 (25.46)		119 (78.81)	32 (21.19)	

^aData are presented as n (%). Number of years played was significantly associated with an increased risk of having at least 1 concussion in both male and female athletes ($P \leq .05$; χ^2 test).

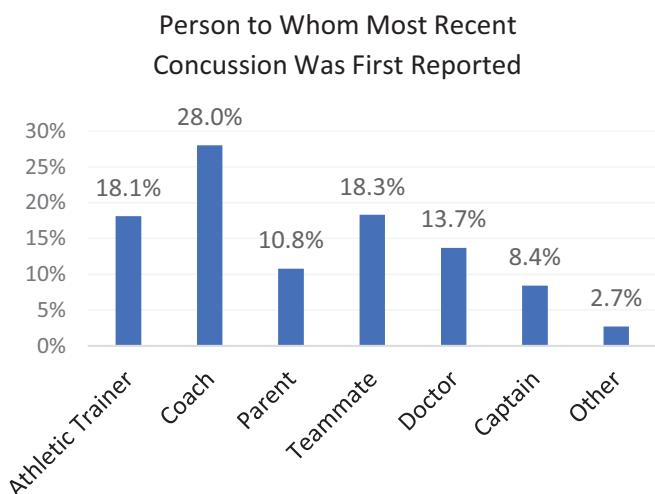


Figure 2. Percentage of respondents selecting the person to whom they first reported their most recent concussion (n = 2263).

concussion, not wanting to be pulled out of the game or practice, not wanting to let others down, and being pressured to stay in the game. These results are summarized in Figure 4.

We found that 57.6% of respondents had at least 1 rugby-related concussion that was diagnosed by a medical provider qualified to make the diagnosis. A qualified medical provider was defined as an athletic trainer, emergency medical technician (EMT), physical therapist, or physician. Of those who reported the concussion to a qualified medical provider, the most commonly cited providers in order of decreasing frequency were physician, athletic trainer, EMT, and physical therapist. These results are summarized in Figure 5.

Only 31.2% of respondents completed a formal return-to-play protocol involving a gradual return to sport, 61.0% did not, and 7.8% were unsure if they completed a formal protocol. Of those who reported a concussion, 32.4% returned to play in the same game or practice in which the concussion occurred. Furthermore, 13.1% of those reporting a concussion only missed the remainder of the game or practice, 15.9% missed 1 to 6 days, and 38.6% missed ≥ 7 days. However, when only those respondents who first reported their

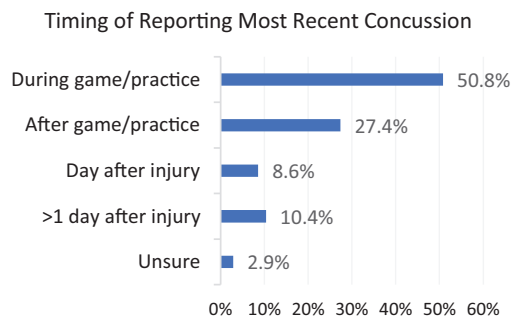


Figure 3. Time frame in which each respondent reported his or her most recent concussion (n = 1428).

concussion to an athletic trainer or physician were considered, the amount of time sidelined increased; 58.9% missed ≥ 7 days, only 10.8% returned to play in the same game or practice, 13.1% missed the remainder of the game, and 17.3% missed between 1 to 6 days. These results are summarized in Figures 6 and 7.

DISCUSSION

To our knowledge, this is the largest survey of players in US rugby union. Overall, 71.0% of responding rugby players with 1 to 10 years of playing experience had sustained at least 1 concussion in their lifetimes. Furthermore, the majority of all responding rugby players (61.9%) reported having had at least 1 rugby-related concussion when shown a definition and asked to anonymously report. This suggests that a concussion is still a risk for rugby players, although this finding must be weighed against the potential benefits of the sport and taken in the context of a survey population with 8.2 years of experience, on average. Our results suggest that male athletes sustain more concussions than do female athletes. This difference might be explained by the difference in age and number of years played between male and female respondents. This, along with the lack of a significant difference in age at the time of the first concussion between male and female respondents, suggests that female athletes likely stop playing earlier and thus shorten their exposure time; hence, they may have fewer concussions as a direct consequence.

Reasons for Not Reporting Most Recent Concussion



Figure 4. Reasons that respondents did not report their most recent concussion to a provider or other person (n = 1359).

Providers to Whom Concussions Were Reported

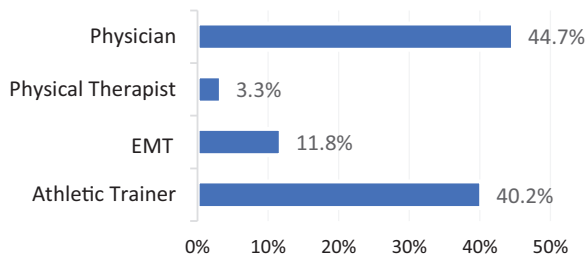


Figure 5. Type of provider to whom respondents were most likely to report their concussions (n = 1239). EMT, emergency medical technician.

Amount of Time Sidelined When Concussion Was First Reported to a Physician or Athletic Trainer

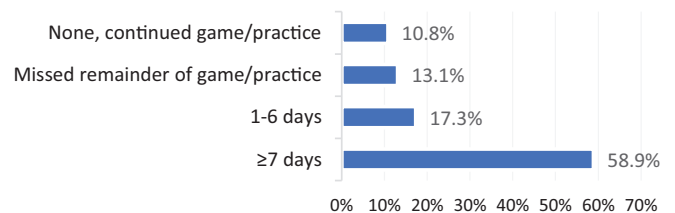


Figure 7. Percentage of respondents who were sidelined for a duration of time after reporting a concussion to a provider (n = 713).

Amount of Time Sidelined After Most Recent Concussion

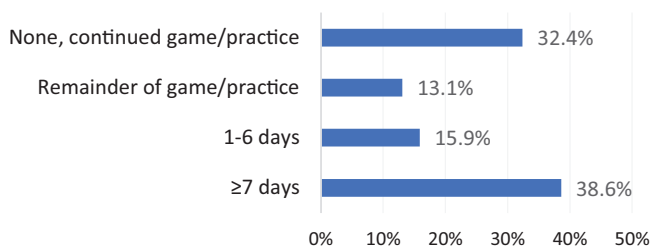


Figure 6. Percentage of respondents who were sidelined from play for a duration of time after experiencing a concussion (n = 1542).

The study findings are consistent with those of previous reports that playing rugby, or any contact/collision sport, is a risk factor for concussions.^{4,15,19,25,26,32,40,52} These findings are important because there is mounting evidence from several studies demonstrating an association between playing contact sports and sustaining concussions^{7,11,32,45} and an association between repeated concussions and long-term neurological disorders.^{2,8,9,12,18,20,35,36} Multiple recent

studies have also found changes in neuroimaging findings, neurometabolic measurements, cerebral blood flow, brain networking, and neurocognitive domains in people with previous concussions.^{3,32,44} Some of the networking and neurometabolic changes have been seen as early as adolescence, although 1 study of American football found no neurocognitive changes after 2 seasons of play in high school students.⁴¹

Our findings on behaviors around reporting were particularly concerning. Over a quarter (27.7%) of participants had at least 1 unreported concussion. This rate is an improvement from the 40% to 50% unreported concussion rate cited in other studies.^{1,14,24} However, of those who did report a concussion, only half (50.8%) reported the concussion during the game or practice, and only 38.6% were sidelined for ≥7 days. Moreover, 32.4% did not take any time off from practice or play at all. The 2017 Concussion in Sport Group consensus statement recommends a minimum of 7 days to progressively return to play after players are asymptomatic at rest,³¹ and USA Rugby recommends return to play after players have been symptom-free for 2 weeks if there is no medical supervision available.⁴⁷

This bimodal distribution of time loss in players who reported concussions likely represents the difference

between reporting the concussion to a medical provider and receiving appropriate management versus self-management or being managed by an otherwise unqualified person. This is supported by our finding that when respondents first reported their concussion to a physician or athletic trainer, 58.9% were sidelined for ≥ 7 days, and only 10.8% returned to play in the same game or practice. This discrepancy suggests that at least part of the issue of inappropriate management can be explained by athletes' lack of access to appropriate providers for diagnosis and management. The majority of respondents (65.5%) reported their concussion to a coach, teammate, parent, or captain before anyone else, while only 18.1% first reported the concussion to an athletic trainer, and 13.7% first reported the concussion to a physician.

USA Rugby manages the concussion risk by regulating equipment, facilities, playing conditions, and certification of coaches and referees. This certification process includes education on managing differences in player skill and experience level and proper player training before match play to minimize the risk of concussions and other injuries, although the risk cannot be completely removed because of the nature of the sport.⁴⁸ When concussions do occur, USA Rugby's Graduated Return to Play policy for community and age-grade players recommends the use of the Pocket Concussion Recognition Tool to "recognize and remove" at-risk athletes from play and direct them to a medical practitioner for appropriate treatment. If no medical practitioner is available, which may be the case at some lower levels of play,⁴⁸ the policy recommends the player have at least 14 days of rest and be symptom-free before beginning the 5-day Graduated Return to Play protocol.⁴⁷ Our data suggest that nonelite rugby matches may have less than optimal medical coverage, with most competitions occurring without an athletic trainer or physician present. There may also be a lack of education on concussion recognition by nonmedical personnel to identify players in need of an immediate evaluation by appropriate providers. World Rugby has highlighted a similar "recognize and remove" strategy for the recognition of concussions by non-medical personnel.⁵¹

While concussion awareness efforts have improved over the years, athletes still may not understand the importance of immediate reporting and removal from play. Of the 27.7% of respondents who had at least 1 unreported concussion, over half selected either "I didn't think that it was serious enough" (34.4%) or "I didn't want to be pulled out of the game or practice" (21.8%) as the main reason for not reporting the concussion. This indicates a lack of understanding of the severity of concussions and dangers of returning to sport too soon. Notably, another 11.7% cited, "I didn't want to let down my teammates/coach/parents," as the main reason for not reporting, suggesting that there is still a stigma or perceived stigma around reporting concussions and removal from play. Two recent surveys, 1 from 2016 of semiprofessional and elite players³⁰ and another from 2017 of youth players,²² have found that many athletes have misconceptions about how concussions can occur, signs and symptoms of concussions, and attitudes about missing playing time during

concussions including return-to-play protocols. The study from 2016 also found similar attitudes in surveyed coaches and medical professionals, indicating that this is not just a player issue and highlighting the importance of concussion education from rugby-governing bodies. Most negative attitudes toward concussion reporting were related to feeling a responsibility to play, especially in important matches,^{22,28} and previous studies have indicated a culture of playing injured for a multitude of reasons,^{16,29} similar to our findings. It should be noted that some surveys have reported sufficient knowledge of a concussion and its risks in certain groups,²⁸ but given the misconceptions that many athletes maintain about the concussion risk, athlete education remains an important method of management for this injury.

There are a number of important limitations to our study. There was no way to know if our sample was representative of athletes in US rugby union, given that USA Rugby does not publish demographic data. Furthermore, because this study analyzed a newly created data set generated from an online anonymous survey of USA Rugby members aged ≥ 15 years, it may not be generalizable to rugby players of all ages or to ones in other countries and levels of play. It is also likely that there were unmeasured confounding variables not included in the study. Recall bias is an important limiting factor in our study, although we did attempt to limit this bias by excluding athletes with more than 10 years of playing experience based on reports that bias is increased ≥ 10 years after the most recent concussion.²⁴ The level of recall bias concerning the number of concussions and age at first concussion may also be different across age levels and by sex. There is no gold standard for the diagnosis of a concussion or reporting concussions, so studies may not be investigating the same condition, especially given that many concussions reported in this study were self-diagnosed. We defined concussion based on the Concussion in Sport Group consensus statement.³¹ It is still possible that respondents were influenced by alternative previous definitions of concussion. Another source of potential information bias is that a year of playing experience may be different by hours played and intensity of play between and within sexes, by geography, and by level of play. Excluding athletes with more than 10 years of playing experience may have limited the power of the study, but this was done to improve comparisons between male and female athletes and to limit recall bias, as mentioned in the Methods section. Finally, nonresponse bias is likely in play, given our relatively low response rate of 20.2%. It is possible that those who did not respond to the email request to fill out the questionnaire were different from those who did with respect to concussion history, recall ability, years of rugby played, sex, or other potentially significant factors. It is acknowledged that a survey about concussions is perhaps more likely to be completed by someone who has had a concussion than someone who has not. While this may have limited our study's ability to estimate the incidence of concussions in US rugby, it still can tell us important information about reporting and return-to-play behaviors in those who have sustained a concussion.

CONCLUSION

To our knowledge, this is the largest study of its kind that has been carried out in the US rugby union population. Concussions are an established risk in rugby union and are often underreported, reported late, or reported to someone who is not qualified to diagnose and treat traumatic brain injuries. Reasons for not reporting vary but mostly involve factors related to access to health care and a lack of education on concussion recognition and the risks associated with continued play after sustaining a concussion. This study suggests that further research is needed to understand concussions and the risks to male and female athletes who play rugby and other contact sports as well as to understand the barriers to reporting concussions in rugby. Further education efforts focusing on recognition, removal from play, and return-to-play protocols, such as the “recognize and remove” strategy that USA Rugby and World Rugby support, are necessary in the US rugby union population.^{47,51}

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APPENDIX

Rugby Concussion Questionnaire^a

All answers are “yes” or “no” selections, drop-down menus of durations of time, or free responses unless otherwise specified.

1. What is your age?
2. What is your sex?
(1) Male (2) Female
3. In which state do you currently reside?
4. Have you played 15s or 7s rugby for at least the majority of 1 season?
Yes ___ No ___
5. What position(s) do/did you play? *Select all positions that apply.*
(1) Prop (tighthead) (2) Prop (loosehead) (3) Second row/lock (4) Hooker (5) Flanker (openside) (6) Flanker (blindsided) (7) No. 8/8-man (8) Scrum-half (9) Stand-off/fly-half (10) Center (outside) (11) Center (inside) (12) Fullback (13) Right wing (14) Left wing
6. At what level do you currently play? *Please leave blank if you do not currently play rugby.*
7. Which positions have you played most over the years when you have played rugby? *Select all positions that apply.*
(1) Prop (tighthead) (2) Prop (loosehead) (3) Second row/lock (4) Hooker (5) Flanker (openside) (6) Flanker (blindsided) (7) No. 8/8-man (8) Scrum-half (9) Stand-off/fly-half (10) Center (outside) (11) Center (inside) (12) Fullback (13) Right wing (14) Left wing
8. How many years have you played or practiced 15s?
9. How many years have you played or practiced 7s?
10. In the years in which you played 15s rugby, how many months per year did you practice, on average?
11. In the years in which you played 7s rugby, how many months per year did you practice, on average?
12. In the years in which you played 15s rugby, how many 15s matches per year did you play, on average? *Only include matches in which you played for half or more total match time.*
13. In the years in which you played 7s rugby, how many 7s matches per year did you play, on average? *Only include matches in which you played for half or more total match time.*

14. While actively training for 15s or 7s, how many times per week did your team practice, on average?
15. How long were these full team practices, on average?
16. How much time was spent on warm-up during each practice, on average?
17. How much time was spent on warm-up before each match, on average?
18. On average, how much time do you spend on strength and conditioning? *Include training outside of organized team practices.*
19. Do you use World Rugby–approved headgear (ie, scrum cap) during the majority of contact practices?
Yes___ No___
20. Do you use World Rugby–approved headgear (ie, scrum cap) during the majority of match play?
Yes___ No___
21. Do you use a mouth guard/mouth piece during the majority of contact practices?
Yes___ No___
22. Do you use a mouth guard/mouth piece during the majority of match play?
Yes___ No___
23. Have you ever played organized sports other than rugby?
Yes___ No___
24. Which organized sport(s) have you played for 2 years or greater at any level or 1 year or greater at the high school level?
(1) American football (2) Boxing (3) Full-contact martial arts (*please specify*) (4) Ice hockey (5) Lacrosse (6) Rodeo (*please specify*) (7) Roller derby (8) Soccer (9) Wrestling (10) Other (*please specify*) (11) None
25. Do you play any of these sports while playing rugby or in the off-season during the years in which you actively play rugby?
Please specify if selected “yes.”
Yes___ No___
- This next section of the survey will ask you about concussions. Please use this definition of a concussion to answer the questions asked: *A concussion is a blow to the head followed by a variety of symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, “seeing stars,” feeling in a fog or slowed down, memory problems, poor concentration, nausea, or throwing-up. Getting “knocked out” or being unconscious does NOT always occur with a concussion.*
26. This question asks about all concussions, both related and unrelated to rugby. Please refer to the definition of a concussion provided above to answer this question. Do you believe that you have had a concussion, based on the definition above?
Please select “yes” if you think that you might have had a concussion, even if you did not tell anyone.
Yes___ No___
27. How many concussions have you had?
(1) Number of rugby-related concussions (*include concussions during a rugby match or practice*) (2) Number of concussions outside of rugby (*include concussions during other sports and unrelated activities*)
Total: _____
28. List your age at the time of each of your _____ concussions, including rugby related and non–rugby related.
29. How did the _____ concussion(s) that occurred outside of rugby happen?
(1) While playing another sport (*please specify*) (2) Other (*please specify*)
The remaining questions refer only to your _____ rugby-related concussions, including those that occurred during a practice or match.
30. How many of the _____ rugby-related concussions happened in a match or practice?
(1) Number of concussions during a rugby match: _____ (2) Number of concussions during a rugby practice: _____
Total: _____
31. What position(s) were you playing at the time of your _____ rugby-related concussion(s)? *Select all positions that apply.*
(1) Prop (tighthead) (2) Prop (loosehead) (3) Second row/lock (4) Hooker (5) Flanker (openside) (6) Flanker (blindsided) (7) No. 8/8-man (8) Scrum-half (9) Stand-off/fly-half (10) Center (outside) (11) Center (inside) (12) Fullback (13) Right wing (14) Left wing
32. Did you report any of the _____ rugby-related concussions? This includes to an athletic trainer, coach, captain, doctor, parent, teammate, or other.
Yes___ No___
33. How many of these _____ rugby-related concussions did you report to a coach, captain, doctor, parent, teammate, or other?
(1) Reported: _____ (2) Did not report: _____
Total: _____

34. To whom did you first report the _____ rugby-related concussions? *Please select multiple choices only if you have had multiple concussions and reported each of them to a different person first.*
(1) Athletic trainer (2) Coach (3) Parent (4) Teammate (5) Doctor (6) Captain (7) Other (*please specify*)
35. When did you first report the _____ rugby-related concussion(s)? *Select all that apply.*
(1) During game/practice (2) After game/practice (3) Day after injury (4) More than 1 day after injury (5) Unsure
36. Were there any rugby-related concussions that you did not report?
Yes___ No___
37. Why didn't you report the _____ concussions? *Select all that apply.*
(1) I didn't think that it was serious enough (2) I didn't want to be pulled out of the game or practice (3) I didn't want to let down my teammates/coach/parents (4) I didn't know that it was a concussion (5) I was pressured to stay in the game by my teammates, coach, or others (6) Other (*please specify*)
38. Were any of these _____ rugby-related concussions diagnosed by an athletic trainer, emergency medical technician (EMT), physical therapist, or physician?
Yes___ No___
39. Please select which type of medical personnel diagnosed your _____ rugby-related concussion(s).
(1) Athletic trainer (2) Emergency medical technician (EMT) (3) Physical therapist (4) Physician
The remaining questions ask only about your most recent rugby-related concussion.
40. To the best of your knowledge, what were you doing at the time of your most recent rugby-related concussion? *Select all that apply.*
(1) Action (2) Direction (3) Head made contact with another player's
41. Were you wearing a scrum cap at the time of your most recent rugby-related concussion?
Yes___ No___
42. Were you wearing a mouth guard/mouth piece at the time of your most recent rugby-related concussion?
Yes___ No___
43. Did you complete a formal return-to-play protocol for your most recent rugby-related concussion? This refers to a program in which you gradually returned to full activities under the supervision of a health care provider (trainer, physical therapist, and/or physician).
Yes___ No___
44. How long were you sidelined before returning to play after your most recent rugby-related concussion?
(1) None, continued game/practice (2) Missed remainder of game/practice (3) 1-6 days (4) 7 days or longer

^a7s, 7 players per side, games played in two 7-minute halves for 14 minutes total; 15s, 15 players per side, games played in two 40-minute halves for 40 minutes total.