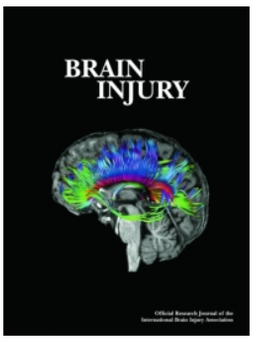

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Differences in Sport-Related Concussion History, Reporting Behavior, and Return to Learn and Sport Timelines in Public versus Private High School Student Athletes

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ABSTRACT

Objective: To compare: 1) history of sport-related concussion (SRC), 2) Return to learn (RTL) timelines, 3) Return to play (RTP) timelines, and 4) SRC reporting behaviors in high-school student athletes based on school type (public vs. private).

Methods: A total of 2,998 athletes recruited from eleven private (n = 2121) and two public schools (n = 877) during the 2018–2019 school year completed an online questionnaire regarding sport participation and SRC history. The questionnaire examined self-reported history of SRC, reporting behavior, and RTL and RTP timelines.

Results: Private school athletes were approximately twice as likely to report a history of SRC compared to public school athletes (OR [95% CI]: 2.01 [1.61–2.50], $p < .001$). There were no significant differences in RTL or RTP timelines between public and private-school athletes ($p > .05$). For those who did not report their SRC (22.4%), the most common reasons were "a desire to keep playing" (53.7%) and "not believing it was serious enough to report" (52.1%).

Conclusions: Athletic trainers and healthcare professionals should be aware of the factors that may influence secondary student athletes' SRC reporting behavior, and associated RTL, and RTP timelines, so they can better target concussion education and overall management for student-athletes.

Abbreviations: SRC: Sport-related concussion; RTP: Return to play; RTL: Return to learn

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Secondary schools; academic accommodations; concussion; athletic training

Introduction

Nearly 8 million adolescents in the United States participated in high-school athletics during the 2018–2019 school year (1). While participation in sports has been demonstrated to lead to a variety of positive short- and long-term outcomes, such as lower risk of obesity and better overall psychosocial health, there has been increasing concern about the potential impact of sport-related concussions (SRC) on the health of youth athletes (2–4). In 2017, an estimated 2.5 million high-school students sustained an SRC within the previous year.[5] A variety of factors have been identified as risk factors for SRC in youth sports, including history of previous concussion, sex, sport contact level, and age (5–8). To date there has not been an examination of the differences in SRC occurrence based on secondary educational setting (public vs. private high schools). Previous research has reported differences in athletic trainer availability between public and private high schools (9–11), which has been shown to influence SRC diagnosis and management (12). Additionally, certain private school settings require participation in athletics by all students, which may influence SRC risk or reporting behavior. For example, a student with no background in physical activity or sport who is required to participate in athletics may lack the neuromuscular control or awareness to avoid collisions that may result in an SRC.

As a result of increased awareness regarding the negative health impact of SRCs, greater attention has been given to the importance of timely SRC reporting and management post-injury. Post-injury management should include a gradual return to learn (RTL), incorporating academic support strategies as needed, followed by a return to play (RTP) protocol. Best practices and needed supports specific to RTL continue to evolve as more attention and formal research occurs (2). However, the topic of RTP following an SRC has attracted considerable attention due to the importance of minimizing the risk of catastrophic consequences related to subsequent trauma. Recent evidence suggests that RTP timelines in high-school athletes are influenced by age and sex, with female athletes and younger athletes taking a longer time to return to sport (13). Less is known about factors that influence RTL timelines. But recently, the importance of a gradual progression back into academic activities ("return to learn" or RTL) for student-athletes who sustain an SRC has received increased attention, due to the potential for academic challenges post-injury (6,14–20). What is not known is whether the educational setting of the high-school student-athlete (public vs private school) influences the RTL or RTP timelines.

As mentioned above, a student-athlete must first be willing to report their SRC to a healthcare provider in a timely manner to receive rapid evaluation and effective management of their

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SRC. Recent investigations have examined reasons for non-disclosure among student-athletes (21–23). Key reasons for non-disclosure of SRCs among high-school and collegiate athletes include lack of knowledge regarding SRCs, internal and external pressures or support, and perceived attitudes toward SRCs (21–24). With increased scientific and media attention on the importance of prompt reporting, evaluation, and management of SRCs in the professional and collegiate athlete, it is crucial to examine whether these non-disclosure factors are relevant among high-school athletes in different educational settings. Recent data has examined SRC history, RTL/RTP timelines, and SRC reporting behavior in the private school setting (25,26), but to date there has not been a comparison of these outcomes between public and private high-school student athletes.

The purpose of this study was to describe and compare: 1) history of SRC, 2) RTL timelines, 3) RTP timelines and 4) SRC reporting behavior in high-school athletes based on high-school type (public vs. private). We hypothesized that there would be no differences between private and public high-school student athletes specific to self-reported history of SRC, RTL and RTP timelines, or SRC reporting behavior.

Materials and methods

Participants

The Institutional Review Board at Connecticut Children's Medical Centerapproved this study on April 6, 2018. Male and female high-school student athletes were recruited during the 2018–2019 school year from a convenience sample of 13 schools (eleven private, two public) in Connecticut, Maine, Massachusetts, New Hampshire, New York, and Rhode Island. The two public schools in this study each employed part-time athletic trainers who were available after school during the week, while the eleven private school each employed a full-time athletic trainer who was available 40+ hours per week.

Student athletes were asked to complete a voluntary, anonymous survey as part of a project sponsored by the nonprofit organization, PINK Concussions. Parental consent was waived due to minimal risk, but parents of the participants at each school received a notification of the study by e-mail that provided them with an opportunity to opt-out of the study prior to study start. Assent was assumed when the high-school student athletes clicked past the information page of the survey, acknowledging their willingness to participate.

The survey was distributed to 6,923 students (3,116 private-school students, 3,807 public-school students). A total of 3,532 students completed the survey (51.0% response rate), with 534 students (15.1%) excluded from the final analysis because they reported not currently playing a sport (N = 532) or because their gender was reported as non-binary (N = 2). A final sample of 2,998 student-athletes were retained for analysis (43.3% effective response rate). The effective response rate from private school students was 68.1% (n = 2121) compared to an effective response rate of 23.0% (n = 877) among public school students. The private school students were asked to complete their survey in their small advisory period with their advisor present. The public school students were asked to complete the survey by their teachers in their health class or gym class, and were in much larger classroom settings.

Questionnaire

Student-athletes were invited to participate in a voluntary, anonymous, online questionnaire regarding their sport participation and SRC history. The questionnaire could be completed on a computer or smart phone and included the following sections: 1) demographic information such as gender, grade, and primary sport, 2) history of self-reported SRC, 3) self-reported RTL and RTP timelines following their SRC, 4) questions regarding pretending to have a faster or slower recovery during the RTL or RTP process, and 5) SRC reporting behavior, including whether the student-athlete had ever not reported their SRC to a parent, coach, athletic trainer, or other medical professional, and the most common reasons that they did not report their SRC. The survey was pilot tested prior to formal study administration in 365 high-school students and revised as appropriate.

Study definitions

Concussion and SRC: Participants were specifically asked "Have you ever had a concussion?", with the following definition provided: "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 concussions" (27). If participants indicated "yes" to this question, they were provided two follow-up questions: "How many of your concussions were related to organized sports?" and "Of your sports-related concussions, how many did you receive while playing for your school?". Based on these follow-up questions, a SRC was defined as a concussion that occurred during organized sports participation at their school. For RTL and RTP timelines, student-athletes were asked to indicate how long it took them to return to a full academic workload and how long it took them to return to their sport and play in games. Response options included: less than 7 days, 7 to 13 days, 14 to 20 days, and 21 days or more. The primary sport indicated by the student-athlete was used to classify them as either a contact or non-contact sport athlete.

Contact-sport versus non-contact sport: A contact-sport athlete was defined as a participant in a full or limited contact sport, where there is intentional or incidental contact with an opponent. Non-contact athletes were defined as athletes in sports where there is no or rare incidental contact with opponents. Contact sports included basketball, field hockey, football, hockey, lacrosse, and soccer, while non-contact sports included baseball, crew, cross-country, golf, softball, squash, tennis, and volleyball. Since there were no cheer athletes at the private schools in this study, those athletes were considered "other" for their primary sport and were excluded from any

analysis that compared contact and non-contact athletes for sport type.

Statistical analysis

Data were summarized using frequencies and proportions (%). Chi-square tests were used to examine univariate associations between history of SRC and RTL/RTP timelines based on school type. Chi-square tests were also used to examine the associations of potential covariates (gender, grade, and sport-type: contact vs. non-contact) with history of SRC, stratified by school type. Multivariate logistic regression was used to examine associations between school type and history of SRC, adjusting for the covariates above. Odds ratios (ORs) with 95% confidence intervals (95% CI) were calculated from the logistic regression model, adjusting for covariates. An alpha level of 0.05 was set a priori to determine statistical significance for all tests. All analyses were performed using SPSS statistical software (v25.0; IBM Corp.).

Results

Participant demographics are presented in Table 1. Overall, 28.0% (N = 838) of all student-athletes reported a previous history of SRC. Private high-school athletes were more likely to report a history of previous SRC (N = 660, 31.1%) compared to public high-school athletes (N = 178, 20.3%, $p < .001$).

Table 1. Participant Demographics (N = 2998).

Variable	N (%)
Gender	
Male	1415 (47.2%)
Female	1583 (52.8%)
Non-binary*	2 (0.00%)
Grade	
9th	1037 (34.6%)
10th	704 (23.5%)
11th	673 (22.4%)
12th	584 (19.5%)
School Type	
Private	2121 (70.7%)
Public	877 (29.3%)
Primary Sport	
Baseball	126 (4.2%)
Basketball	223 (7.4%)
Crew	130 (4.3%)
Cross Country	123 (4.1%)
Field Hockey	128 (4.3%)
Football	95 (3.2%)
Golf	63 (2.1%)
Hockey	125 (4.2%)
Lacrosse	300 (10.0%)
Soccer	454 (15.1%)
Softball	101 (3.4%)
Squash	96 (3.2%)
Tennis	228 (7.6%)
Volleyball	158 (5.3%)
Other	648 (21.6%)
Sport Type**	
Contact	1325 (56.4%)
Non-contact	1025 (43.6%)
History of Sport-Related Concussion	
Yes	838 (28.0%)
No	2160 (72.0%)

*Excluded from all analysis due to lack of responses.
**Only includes athletes who listed a primary sport that was not "other" (N = 2350).

Differences in history of SRC reporting by gender, grade, and sport type stratified between private and public-high-school athletes are presented in Table 2. Male private high-school athletes were more likely than female private high-school athletes to report an SRC (36.7% vs. 26.1%, $p < .001$), but there were no differences between male and female public-high-school athletes in SRC history ($p = .12$). Similarly, older private school athletes were more likely to report an SRC ($p = .004$), but there were no differences in SRC history based on grade among public school students ($p = .81$). Contact-sport athletes were more likely than non-contact sport athletes to report an SRC in both the private ($p < .001$) and public school ($p = .002$) settings. After adjusting for gender, grade, and sport-type, private school athletes were approximately twice as likely to report a history of SRC compared to public school athletes (OR [95% CI]: 2.01 [1.61–2.50], $p < .001$).

Overall and school-type specific RTL and RTP timelines are presented in Figures 1 and 2. In this cohort, the majority of athletes (n = 603; 72.0%) reported returning to school within 13 days following their SRC. The overall distribution for the RTP timeline was more evenly distributed, with just over half of all athletes (n = 442; 52.8%) reporting that they were able to return to their sport within 13 days. There were no significant differences in RTL or RTP timelines between public and private-school athletes ($p > .05$). There was a significant difference in the RTL timeline between male and female athletes, with a larger proportion of female athletes reporting that it took them 21 days or more before they were able to return to a full academic workload (20.0% female vs. 7.4% male, $p < .001$). Female athletes were also more likely than males to report that it took 21 days or more before they were able to return to their sport and play in games (29.6% female vs. 21.2% male, $p = .02$) (Figures 3 and 4).

Of the athletes who reported a history of SRC, very few reported pretending to have a slower recovery so that they could stay out of school (N = 29, 3.6%) or sports (N = 17, 2.1%) longer than they actually needed. In these cases, the athlete reported they were no longer experiencing symptoms, yet reported to teachers or parents that they were still symptomatic. Approximately one-fourth of athletes reported pretending to have a faster recovery so that they could return to school (N = 193, 23.7%) or sport (N = 211, 26.0%) sooner than they should have returned. In these cases, the student continued to experience symptoms, but reported to teachers or parents that they were asymptomatic. There were no significant differences in the responses to these questions based on school type. Female athletes were more likely than male athletes to report pretending to have a faster recover so they could return to school sooner (29.7% female vs. 18.4% male, $p < .001$). There were no differences between males and females in pretending to return to sport sooner.

Of the athletes that reported a previous history of SRC, 22.4% (N = 188) indicated that they had not reported at least one of their SRCs to their parents, coach, athletic trainer, or other medical professional. The most common reasons for not reporting are presented in Table 3. Overall, the most commonly selected reasons were a desire to keep playing (53.7%), not thinking concussions were serious enough to report (52.1%), and not wanting to let their teammates down

Table 2. Comparisons of SRC by Gender, Grade, and Sport Type Stratified by School Type.

	History of SRC – Private Schools			History of SRC – Public Schools		
	Yes (n = 660)	No (n = 1461)	P	Yes (n = 178)	No (n = 699)	P
Gender			<.001			0.12
Male	369 (36.7%)	636 (63.3%)		74 (18.0%)	336 (82.0%)	
Female	291 (26.1%)	825 (73.9%)		104 (22.3%)	363 (77.7%)	
Grade			.004			0.81
9th	185 (27.2%)	495 (72.8%)		69 (19.3%)	288 (80.7%)	
10th	157 (30.9%)	351 (69.1%)		44 (22.4%)	152 (77.6%)	
11th	145 (30.8%)	326 (69.2%)		39 (19.3%)	163 (80.7%)	
12th	173 (37.4%)	289 (62.6%)		26 (21.3%)	96 (78.7%)	
Sport Type*			<.001			0.002
Contact	343 (38.8%)	540 (61.2%)		104 (23.5%)	338 (76.5%)	
Non-contact	192 (24.0%)	607 (76.0%)		30 (13.3%)	196 (86.7%)	

*Only includes athletes who listed a primary sport that was not "other" (N = 2350).

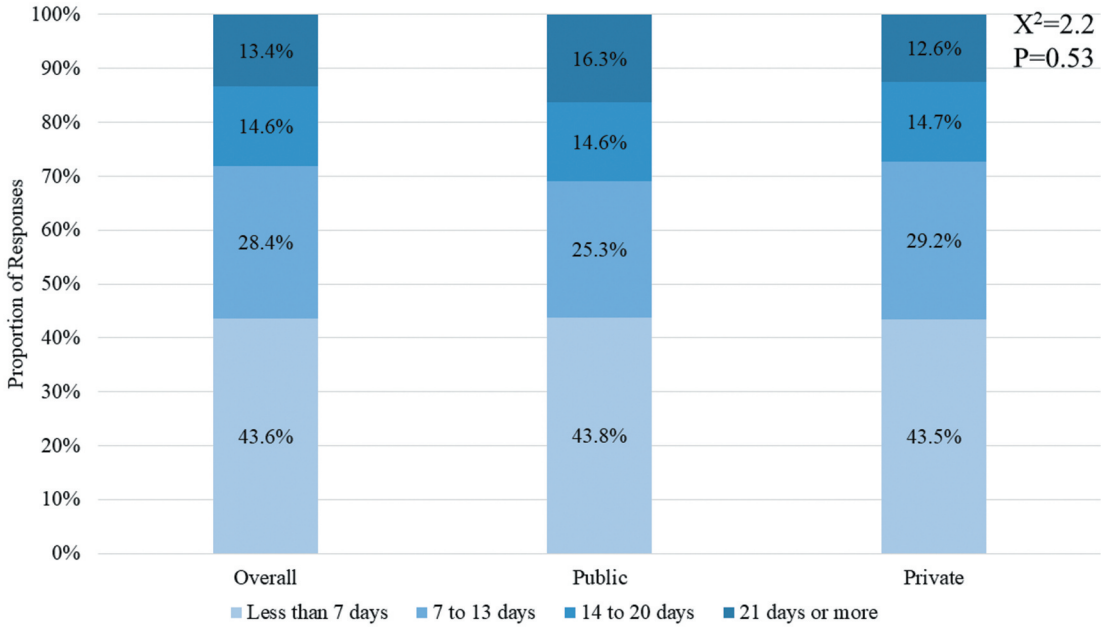

Figure 1. How long did it take to return to a full academic workload (Public vs Private)?

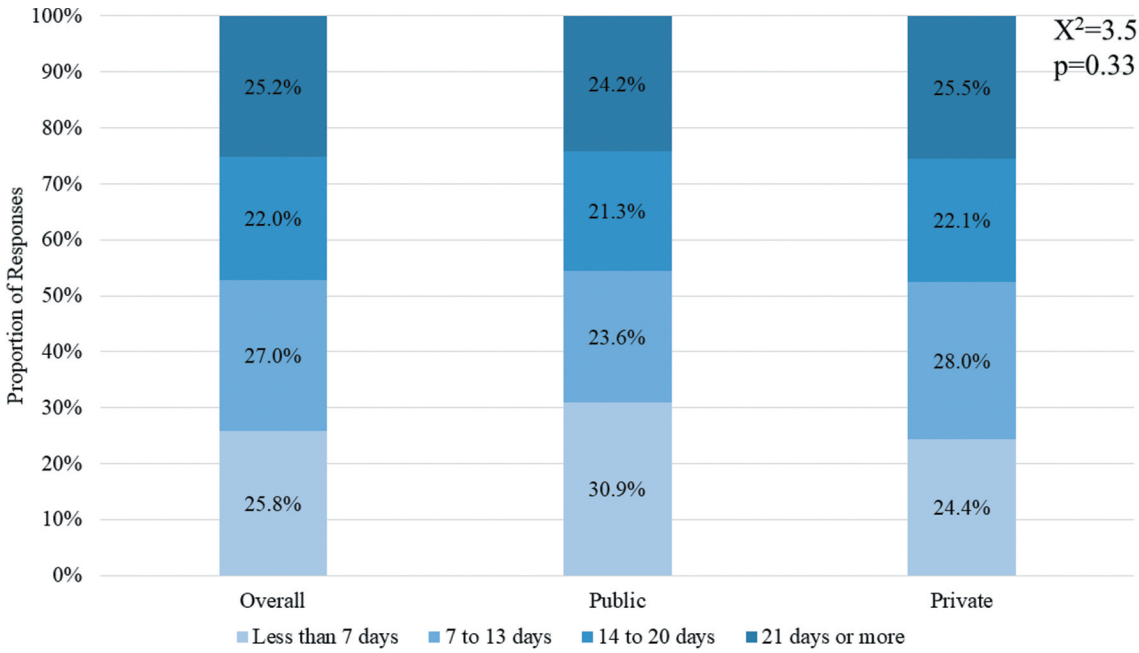

Figure 2. How long did it take to return to your sport and play in games (Public vs Private)?

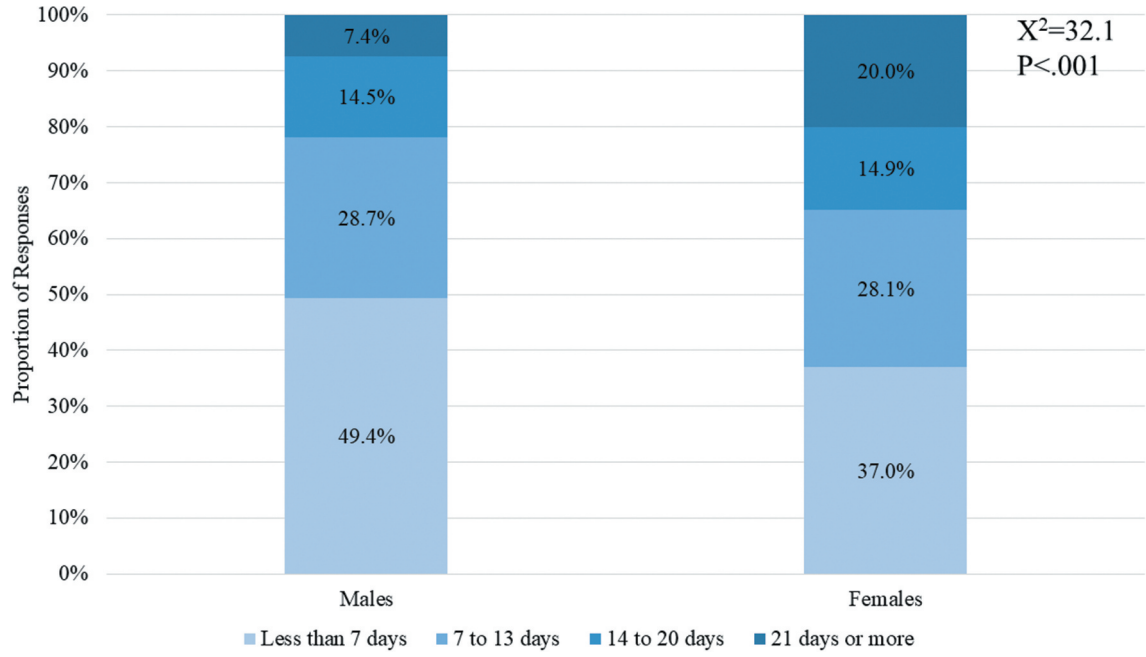

Figure 3. How long did it take to return to a full academic workload (Male vs. Female)?.

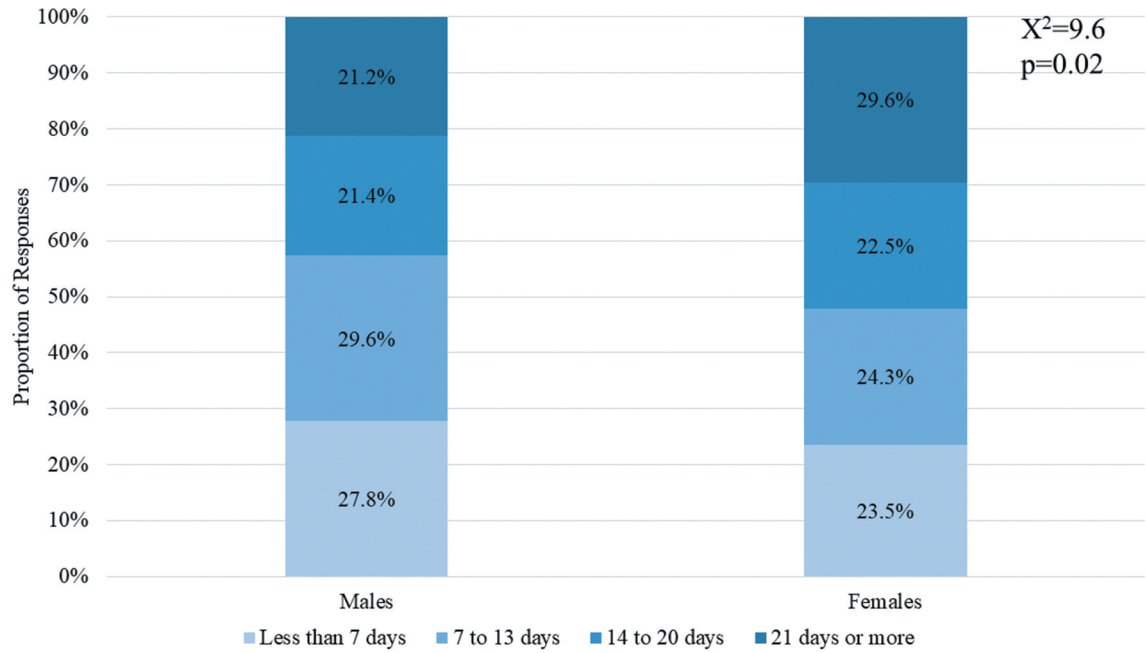

Figure 4. How long did it take to return to your sport and play in games (Male vs. Female)?.

(29.8%). These were consistent as the top three reasons between private and public school athletes, although the order of importance was slightly different (Table 3).

Discussion

The most important findings of this study were that 1) private school athletes were approximately twice as likely to report a previous history of SRC compared to public school athletes, 2) the majority of athletes reported returning to school and sport within 13 days, with no differences between public and private school athletes, 3) approximately one in four athletes with a history of SRC reported pretending to have a faster recovery to return to sport or school faster, and 4) approximately one in five student athletes with a history of SRC reported that they hid at least one of their SRCs from their parents, coach, athletic trainer, or other medical professional. To our knowledge, this is the first study to compare RTL and RTP timelines and behavior based on school type.

When stratified by school type, male private school athletes were more likely than female private school athletes to report a history of SRC but there were no differences between male and female public-school athletes. Among the entire sample, private school student-athletes were also more likely to report

Table 3. Reasons for not reporting SRCs to parents, coaches, athletic trainer, or other medical professional.

	I didn't know I had a concussion	I thought it wasn't serious	I didn't want to let my team down	I wanted to keep playing	I felt pressure from my coach to play	I felt pressure from my teammates to play	I felt pressure from my parents to play
Overall (N = 188)	41 (21.8%)	98 (52.1%)	56 (29.8%)	101 (53.7%)	16 (8.5%)	21 (11.1%)	10 (5.3%)
School Type							
Private (N = 147)	29 (19.7%)	76 (51.7%)	44 (29.9%)	83 (56.5%)	14 (9.5%)	14 (9.5%)	7 (4.8%)
Public (N = 41)	12 (29.3%)	22 (53.7%)	12 (29.3%)	18 (43.9%)	2 (4.9%)	7 (17.1%)	3 (7.3%)

Responses are presented as N (%) within each population group (ie. N (%) of private school responses).
Participants were allowed to select multiple reasons for not reporting their SRC, so total percentages do not add to 100%.

a history of SRC compared to public school student-athletes. This finding may be a result of the unique environment of the private schools that participated in this study. All of the private schools that participated in this survey require their students to participate on at least one athletic team each year of high school. This obviously yields greater sport exposure for private school student-athletes vs. the public-school student-athletes, where athletics are not a requirement. Private school student-athletes may be at greater risk of sustaining an SRC as a result of not having an extensive sport participation history that could prepare them for the movements and body awareness that is necessary for safe sport participation. However, we are not able to support or refute this theory based on this study's methods or previous findings within the literature. Another factor that may have contributed to this difference in SRC history may be the availability of athletic trainers between the public and private schools in this study. The ATs at the public schools in this study were part-time, in comparison to full-time ATs at the private schools. Previous research has indicated that access to a full-time AT results in greater concussion reporting and greater recognition of SRCs (12).

We found no differences between public school and private school athletes in RTL/RTP timelines, with the majority of athletes reporting returning to school (72%) or sports (53%) within 2 weeks. To our knowledge, this is the first study to examine the proportion of athletes who pretend to have a faster or slower recovery to stay out or return early to school or sport. We found that approximately one in four athletes with a history of SRC pretended to have a faster recovery so they could return to school (24%) or sport (26%) sooner. This finding may represent unique cultural pressure that results from being away from friends and social activities. This may be a result of previously identified differences in sport culture between different sports that may minimize the severity of concussions or demonstrating toughness by encourage playing through injuries (22,28). Interestingly, very few athletes reported pretending to have a slower recovery so that they could stay out of school or sports longer. These findings are in contrast with anecdotal concerns and experiences of coaches, administrators, and teachers who are concerned that students are trying to use SRCs as an excuse to game the system and stay out of school longer, and indicates that adolescent athletes, most specifically in this current investigation, appear to be overwhelmingly truthful in their concussion symptom reporting.

Approximately one in five (22.4%) student-athletes with a history of SRC indicated that they did not report at least one of their SRCs to their parents, coaches, athletic trainer, or other medical professional. This rate of non-disclosure is an improvement when compared to previously reported data at the high-school level. In a sample of 167 high-school athletes from 2013, only 40% of all concussion events were reported, compared to the reporting rate of 77% in the present study (23). The rate of non-disclosure observed in our population is lower than data reported by Kerr et al. in 2016, which reported that 33% of collegiate athletes did not report at least one SRC (21). While the rates of non-disclosure in our sample may differ from previous studies of high-school and collegiate athletes, the reasons for non-disclosure are similar to previous

research. Lack of knowledge regarding SRCs and internal pressure have been repeatedly identified as a key factor for non-disclosure of SRCs by student-athletes (21–24). The top three reasons cited by student-athletes for not reporting their SRC were a desire to keep playing (internal pressure), not thinking concussions were serious enough to report (lack of knowledge), and not wanting to let their teammates down (internal pressure). These findings are similar to previously reported data on this topic, which have consistently identified perceived lack of severity and not wanting to be taken out of a game or let teammates down as primary reasons for non-disclosure of SRCs (23,29). Participants also reported external pressures from coaches, parents, and teammates, but these factors ranked much lower in the participant's self-reported decision-making. The fact that not believing their concussion was serious enough to report, as a common reason for non-disclosure, is concerning in light of the significant public attention given to the topic of concussion and highlights the continuing importance of concussion education and awareness campaigns.

There are several limitations to note in this study. First, all information was self-reported by the student-athletes and there were differences in response rate between the public and private schools, so there is a potential for recall or nonresponse bias. Student-athletes may not have accurately recalled their SRC history, RTL and RTP timelines following SRC, or reasons for not reporting their SRC to a parent, coach, or medical professional. For example, the return-to-school and return-to-play questions were phrased as returning to school or sport faster than they "should have", which is a subjective measure and may differ between students. Additionally, reported concussions were not validated through an external source such as medical records. Previous research by Asken et al. has reported that the reliability of self-reported SRC is questionable (30). For example, there is a possibility that student-athletes who were more inclined to seek medical care or who had better access to medical care may have over-reported their history of SRC. However, since all participating schools had at least one athletic trainer on staff, which may have improved the knowledge of students regarding SRC and may have made their SRC history easier to recall, since they likely would have interacted with the athletic trainer because of their injury. Finally, all private schools in this study provided annual concussion education to all of their athletes, and all public-school athletes are required to receive annual concussion education prior to interscholastic participation according to Connecticut state law. Therefore, even though this study relied on self-report, because of the prior education provided by the participants' schools, the athletes in this study are assumed to have general awareness of SRCs, which may have aided accurate recall. Finally, all data were collected from 11 secondary schools located across five northeastern states. Therefore, further research is necessary to determine whether the differences observed based on school type are similar or generalizable to other regions of the country.

Conclusion

Approximately one-quarter of all high-school student-athletes surveyed reported a previous history of SRC, with private school athletes approximately twice as likely as public school athletes to report a previous history of SRC. The majority of athletes reported returning to school and sport within 13 days, and approximately one in four athletes with a history of SRC reported pretending to have a faster recovery to return to sport or school faster. One in five athletes with a previous SRC indicated that they did not disclose their SRC to their parents, coaches, and/or medical professionals. Athletic trainers and other healthcare professionals involved in the care of high-school athletes should be aware of potential differences between public and private school athletes in SRC history. Further research is needed among larger samples of high schools across the country to determine whether educational setting is similarly associated with SRC history. By determining the factors associated with SRC history and reporting behavior, schools can better target concussion education to their own students.

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