Clinical Recovery Timelines following Sport-Related Concussion in Men’s and Women’s Collegiate Sports

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ABSTRACT

Context: Past work has identified sex differences in sport-related concussion (SRC) incidence and recovery time; however, few have examined sex differences in specific recovery trajectories: time to symptom resolution, return-to-academics, and return-to-athletic activity across collegiate sports.

Objective: To examine sex differences in SRC recovery trajectories across a number of varsity sports with differing levels of contact.

Design: Descriptive Epidemiology Study.

Setting: College varsity and club sports.

Patients or Other Participants: SRCs sustained by student-athletes (N=1,974; 38.7% female) participating in Ivy League sports were tracked from 2013/14-2018/19.

Intervention(s): Athletic trainers collected concussive injury and recovery characteristics as part of the Ivy League-Big Ten Epidemiology of Concussion Study’s surveillance system.

Main Outcome Measure(s): Time to symptom resolution, return-to-academics, and return-to-limited and full athletic activity were collected. Survival analyses determined time from injury to each recovery outcome for males and females by sport. Peto tests compared recovery outcomes between males and female athletes and by sport.

Results: The median time to symptom resolution overall was 9 days [IQR:4,18], return-to-academics was 8 days [IQR:3,15], return-to-limited activity was 12 days [IQR:8,23], and return-to-full activity was 16 days [IQR:10,29]. There were significant differences overall between sexes for median time to symptom resolution (males: 8 days [IQR:4,17], females: 9 days [IQR:5,20], p=0.029) and return-to-academics (males: 7 days [IQR:3,14], females: 9 days...
Within-sport comparisons found that female lacrosse athletes had longer symptom resolution ($p=0.030$) and return to academics ($p=0.035$) compared to males, while male volleyball athletes took longer to return to limited ($p=0.020$) and full ($p=0.049$) athletic activity compared to females.

Conclusion: There were significant differences in recovery timelines between sexes. Females experienced longer symptom duration and time to return-to-academics compared to male athletes, but females and males presented similar timelines for return-to-athletics.

Key Words: athletics, academics, return-to-learn, female

Word Count: 298/300

Key Points:

- Female collegiate athletes exhibited a median 1 day longer symptom duration and experienced a median of 2 days longer time to return-to-academics compared to male athletes.
- Within sport comparisons revealed sex differences for symptom resolution and return-to-academics in lacrosse and return-to-athletic activity in volleyball.
- Male and female collegiate athletes displayed similar times to return to limited and full athletic activities following SRC.
Sport-related concussion (SRC) rates in collegiate sports have seemingly increased based on epidemiological evidence, possibly due to greater awareness and recognition of SRC, as well as developments in guidelines or protocols for SRC management. The majority of research to date has focused on symptom recovery and timelines for return-to-play, which may be a product of SRC consensus statements focusing on the immediate removal from competition, SRC management strategies based on SRC symptoms, and effectiveness of gradual return-to-play protocols. The most recent consensus statement on concussion in sport discusses the importance of gradual return to school protocols. Importantly though, there has been little research designed to understand the nature and length of timelines for athletes returning to academics and sport activities across collegiate sports. Thus, studies that include additional athlete and injury outcome characteristics (i.e., sex, level of contact, time to return-to-academics, return-to-limited activity) across sports will be informative from a descriptive standpoint, by documenting differences in SRC recovery and prognosis. Such descriptive findings may inform SRC management strategies, as clinicians can provide student-athletes with evidence-based, anticipated clinical recovery outcomes based on outcomes displayed in similar sports, and also recognize when to make adaptations to their individualized concussion management plan if a student-athlete is not progressing through a clinical trajectory as expected.

The few studies assessing timelines for academic return following SRC have mainly focused on return-to-learn in adolescent, high school athletes. For example, one recent study of youth athletes found that ~64% reported problems in school and 74% received academic accommodations while recovering from an SRC. Another study of youth American football athletes found that approximately 90% missed more than a week of school after SRC, returning on average 9 days after injury. Although specifics around the academic return of collegiate athletes following a SRC are lacking, studies have reported 5-6 days as the median time to return-to-academics and that, on average, collegiate student athletes miss one day of school.
after SRC.\textsuperscript{6,10} These studies are limited to small sample sizes in younger athletic populations, warranting a more robust study in a larger sample of collegiate athletes. Additionally, coupling return to athletics and academics with other aspects of clinical recovery (e.g., symptom resolution) across sports with varying risk and rates of SRC would provide clinically useful data for clinicians to use during SRC management discussions with collegiate student-athletes.

Past research suggests that females face an increased risk for SRC in sex-comparable sports, report a greater frequency and severity of SRC symptoms, and have protracted recovery patterns (i.e., symptom resolution) compared to male athletes.\textsuperscript{10-12} Additional evidence suggests that sex differences in recovery timelines differ depending on the sport.\textsuperscript{10,11} For example, in one study female collegiate soccer and basketball athletes who sustained a SRC in practice and competition, respectively, demonstrated longer recovery times compared to male athletes in similar activities.\textsuperscript{11} Although limited to adolescent athletes, Desai and colleagues\textsuperscript{13} found that differences in time to clinical recovery on 5 markers of recovery between male and female athletes may be due to modifiable risk factors, such as timing of access to specialized care. In contrast, however, Putukian and colleagues\textsuperscript{14} found no differences in time to symptom resolution or return to competition in male and female athletes, in a sample restricted to four collegiate sports (i.e., basketball, soccer, rugby, water polo). Similarly, Master et al.\textsuperscript{15} reported no differences in return to play time between male and female collegiate athletes overall; however, when stratified by sport contact level, males demonstrated longer recovery than females in limited contact sports and females took longer to recover than males in contact sports. These studies suggest mixed results in sex differences in SRC recovery and prognosis, yet consideration of additional intermediate markers of clinical recovery (i.e., return-to-academics, return-to-limited activity) are limited or also demonstrate mixed results.\textsuperscript{9,14} Further, many studies examining clinical recovery timelines post-SRC are under powered to assess the effect of sex. In the current study, we investigated whether clinical recovery trajectories, such as time to symptom resolution, return-to-academics, and return to limited and sport full competition,
differed in a large sample of male and female athletes across a number of collegiate club and varsity sports. We hypothesized that time to each recovery outcome would not differ between males and females.

MATERIALS AND METHODS

We report clinical SRC outcome data from the Ivy League-Big Ten Epidemiology of Concussion Study, a large multi-site collaboration across the Ivy League and Big Ten Universities; only data from the Ivy League are included in the current analysis.

Operational Definitions

Concussion. A SRC was defined using the “Concussion in Sport” guidelines as a traumatic brain injury induced by biomechanical forces resulting in clinical signs and symptoms. Athletic Trainers work in collaboration with team physicians at each school to identify and record student-athletes diagnosed with a SRC by a physician within the sports medicine or Athletics department. At each school, the team physician makes a clinical SRC diagnosis using best practice guidelines for SRC management decisions. Each injury event is not self-reported concussion, but rather clinical diagnosis included in the athletes’ electronic health record.

Clinical Recovery Outcomes. Team physicians and/or athletic trainers made decisions for return to activity and academics based on SRC management protocols at each institution. Inherently, SRC management protocols may not be identical across institutions; however, similar to concussion diagnosis, team physicians and/or athletic trainers follow best practice guidelines for SRC management decisions set forth by the NATA Position Statement and Concussion in Sport Group. Study team members obtained dates for each clinical outcome (e.g., symptom resolution, academic return, return-to-limited activity, return-to-full competition) of student-athletes diagnosed with a SRC. The time to symptom resolution was defined as the time between the date of when the concussive injury occurred and when the athlete reported being symptom free. The time to return to academics was determined from the date the
concussive injury occurred to the date the athlete returned to full academic participation. Also, if an athlete received academic accommodations during their return to academics, study team members indicated this with a binary response (yes/no) in the database. The time to return to limited sport was determined as the time from the date the concussive injury occurred to the date the athlete returned to limited athletic participation, for example at the start of the return-to-play stepwise progression. The time to return to full competition was determined from the date the concussive injury occurred to the date the athlete was cleared to return to full athletic participation; for example, the date the athlete completed their stepwise return-to-play progression.

Procedures

Data collection procedures for the registry database for the Ivy League-Big Ten Epidemiology of Concussion Study have been previously reported. The XXX University serves as the Institutional Review Board (IRB) of record with reliance agreements with the IRB of each site, and informed consent was obtained for each student-athlete prior to the start of each athletic season. After a student-athlete sustained a SRC, athletic trainers reported data regarding demographics, date of injury, and clinical recovery outcomes at each individual site that occurred within 2013-14 to 2018-19 academic years. SRCs resulting from participation in Ivy League sports only within the 2013-14 to 2018-19 academic years were included due to complete participation by all 8 Ivy League schools for these years, and differences between conferences may be a factor in recovery time. Clinical recovery outcomes for each injury event included the dates for 1) symptom resolution, 2) return-to-academics, 3) return-to-limited activity, and 4) return-to-full competition as reported within the database by Athletic Trainers tracking SRC recovery for each athlete. Return to athletic activity outcomes were separated into limited participation, date of sport specific exercise resumption, and full participation, date of full sport participation resumption without restrictions inclusive of full contact practice and/or full competition.
Student-athletes were censored at the end of each academic year, and therefore may have reached these outcomes at a later date. Also censoring occurred in some cases when lost to follow up the end of season or from leaving sports, etc. Follow up data were not available, due to censoring, for symptom resolution in 19.1% of cases (n = 377), return-to-full academics in 25.3% of cases (n = 498), return-to-limited sport in 14.5% of cases (n = 287), and return-to-full activity in 16.9% of cases (n = 333). Also, 38.6% (n = 761) cases had missing information regarding academic accommodations.

Data Analysis

Descriptive statistics presented participant characteristics and clinical recovery outcome measures across male and female collegiate sports in the Ivy League. Independent sample t-tests were used for age and years of competition and chi-square tests were used for categorical variables (e.g., concussion history, academic accommodations) to test for differences between male and female student-athletes. Kaplan-Meier survival curves were used to estimate the time (days) between date of injury and each recovery outcome (i.e., symptom resolution, return to academics, return to limited sport, return to full competition) by sex by sport. Peto tests compared differences in the timing to each of the recovery outcomes between male and female athletes. In addition, to explore and account for the role that concussion history may play, Kaplan-Meier survival curves and Peto tests were used to estimate and compare the time (days) between date of injury and each recovery outcome (i.e., symptom resolution, return to academics, return to limited sport, return to full competition) by concussion history separately for males and females. We then ran similar analyses for each sport while stratifying by concussion history, to examine for sex differences in the timing to each of the recovery outcomes after accounting for concussion history. All analyses were run in StataCorp 2019 (College Station, TX: StataCorp LLC., Stata Statistical Software: Release 16.)

RESULTS
Table 1 presents participant demographics. A total of 1,974 student-athletes (male: 61.3%, n = 1,209) sustained a SRC during the 2013-14 through 2018-19 academic years; 52.2% (n = 1,030) reported at least one previous concussion. There were significant differences between males and females for age ($t_{1,956} = -6.745, p \leq .001$), years competing in sport ($t_{1,956} = -4.647, p \leq .001$), and receiving academic accommodations ($\chi^2 = 8.913, p = .003$). There were no significant differences in previous concussion history ($\chi^2 = 3.943, p = .268$). Table 2 presents total counts and proportions of male (93.4%, n = 1,101) and female (72.9%, n = 552) student-athletes that sustained a SRC in each sport. The incidence of sustaining a SRC was highest in males and females in contact as opposed to non-contact sports. Figure 2 displays the proportion of male and female cases within each sport that had a previous history of one or more concussions.

**Symptom Resolution:** The median time to symptom resolution overall was 9 days [IQR: 4,18]; 8 days [IQR: 4,17] for males and 9 days [IQR: 5,20] for females ($p = 0.029$; Figure 1a). At 7- and 14-days post-injury, 55.1% and 30.7% of athletes, respectively, were still experiencing symptoms, while at $\geq$ 35 days post-injury, 11.7% of student-athletes were still experiencing symptoms (Supplemental Table 1). A greater proportion of females experienced longer symptom resolution ($\geq$7 days: 57.6%, $\geq$14 days: 32.6%, $\geq$35 days: 13.2%) compared to males ($\geq$7 days: 53.4%, $\geq$14 days: 29.5%, $\geq$35 days: 10.7%; Supplemental Table 1) at each time point. Time to symptom resolution was not statistically different by previous concussion history for males; however, those with no previous concussions had faster time to symptom resolution (Figure 3A). For females, there were no significant differences for symptom resolution time between concussion histories, however those with 3 or more previous concussions demonstrated longer symptom resolutions (Figure 4A).

**Return-to-Academics:** The median time to return-to-academics overall was 8 days [IQR: 3,15]; 7 days [IQR:3,14] for males and 9 days [IQR: 4,17] for females ($p<.001$; Figure 1b). At 7- and 14-days post-injury, 50.6% and 26.7% of athletes, respectively, had not returned to
academics, while at ≥ 35 days post-injury, 11% had not returned to academics (Supplemental Table 2). A greater proportion of females took longer to return to academics (≥7 days: 55.5%, ≥14 days: 29.8%, ≥35 days: 13.5%) compared to males (≥7 days: 47.4%, ≥14 days: 24.0%, ≥35 days: 9.3%; Supplemental Table 2) at each time point. Time to academic return was statistically different between males by number of previous concussions (Figure 3B). For females, there were no significant differences for symptom resolution time between concussion histories, however those with more previous concussions demonstrated longer time to academic return (Figure 4B).

Return-to-Athletics: The median time to return-to-limited activity overall was 12 days [IQR: 8,23]; 11 days [IQR: 8,21] for males and 14 days [IQR: 8,26] for females (p = .107; Figure 1c). At 7- and 14-days post-injury, 75.9% and 42.3% of athletes, respectively, had not returned to limited activity; while at ≥ 35 days post-injury, 14.3% had not returned to limited activity (Supplemental Table 3). Time to limited return not was statistically different by number of previous concussions for males (Figure 3C), or females (Figure 4C). For both males and females, those with more previous concussions demonstrated longer return to limited activity.

The median time to return-to-full activity overall was 16 days [IQR: 10,29]; 15 days [IQR: 10,26] days for males and 17 days [IQR: 10,34] for females (p = .578; Figure 1d). Less than 15% of student-athletes did not return-to-full participation within 7 days of injury, over half (53.1%) did not return-to-full activity within 14, and 19.4% were still not returned 35 days beyond their injury (Supplemental Table 4). Time to full return not was statistically different by number of previous concussions for males (Figure 3D), or females (Figure 4D). For both males and females, those with more previous concussions demonstrated longer return to full activity.

Individual Sport Characteristics. Clinical recovery outcomes by sport are included in Supplemental Tables 1-4. American Football (n = 487), female rugby (n = 134), male ice hockey (n = 122), and male lacrosse (n = 114) had the highest total number of SRCs (Table 2). Male basketball, female diving, female squash, male soccer, and male water polo showed the highest
proportions of student-athletes experiencing persistent symptoms >35 days after injury (Supplemental Table 1). For return-to-academics, male and female basketball, male and female rugby, and male and female soccer had the highest proportions of student-athletes not returning to class >35 days after SRC (Supplemental Table 2). Female equestrian, male and female rugby, and male sailing, male squash, and male and female tennis had the highest proportion of student-athletes not returned to limited activity >35 days after injury (Supplemental Table 3), while many sports had high proportions of athletes not returned to full activity >35 days after injury (Supplemental Table 4). Within-sport comparisons yielded longer symptom resolution ($p=0.030$) and return to academics ($p=0.035$) for females in lacrosse compared to males; in volleyball males took longer to return to limited ($p=0.020$) and full ($p=0.049$) athletic activity compared to females. The supplemental tables also report on the timing to each outcome by sex for each sport after stratifying by concussion history.

DISCUSSION

In this large multi-site study, we report timelines for clinical recovery outcomes using a crude analysis for collegiate student-athletes of all sports across all Ivy League institutions. Overall, student-athletes demonstrated a median of 9 days for full symptom resolution, 8 days for return-to-academics, 12 days to return-to-limited sport, and 16 days to return-to-full activity. Across all time measures, female athletes overall experienced longer symptom resolution trajectories and return-to-academics compared to male athletes. The median difference in one day for symptom resolution between male and female groups as a whole may not be clinically significant, and therefore, we point to sex differences noted within sports (e.g., lacrosse).

Further, although female and males overall did not differ in median time to return to limited activity or full activity, the Kaplan-Meier survival curves present a spread between males’ and females’ return to play outcomes particularly those with longer recoveries. Also, within sport sex differences were noted for return-to-athletic activity (e.g., volleyball). Importantly, the Kaplan-Meier survival curves demonstrate heterogeneity in recovery progression, providing further
support for individualized concussion management strategies. Together, these findings are clinically relevant for sports medicine providers to refer to during SRC management decisions, particularly when advising athletes in different sports, as well as to help inform discussions with collegiate student-athletes on differences in recovery trajectories.

We provide information for each clinical outcome measure by sex for each sport in the supplemental data using a crude analysis, to present the most transparent information on the experience of student-athletes with a SRC, and separately after stratifying by previous concussion history. As shown in the supplemental tables, sports with a greater proportion of athletes with a longer symptom duration included male basketball, female diving, female squash, male soccer, and male water polo. For longer academic return, key contributing sports included male and female basketball, male and female rugby, and male and female soccer.

Similarly, a high proportion of male and female athletes across multiple sports still had not returned to limited and full activity weeks after injury. Interestingly, these sports were not limited to contact sports as would be expected, but also included athletes competing in limited or non-contact sports such as squash, tennis, and sailing. Specifically, male limited and non-contact sports accounted for 3.1% and 3.5% of male cases, respectively; female limited and non-contact sports accounted for 14.0% and 13.1% of cases, respectively, in this study. These proportions are important, as not all SRC resulted from contact sport participation; however, differences in proportions warrant cautioned interpretation as representation of male and female participants in some large-roster contact sports, like football, varies. Accordingly, this study did not include an analysis of proportional differences in SRC between males and females at each contact level.

Our findings identifying longer time to symptom resolution in females compared to males is similar to that effect reported in a number of past studies both high school and collegiate athletes, but to our knowledge, the present study is the first to demonstrate sex differences in time to return-to-academics among collegiate student-athletes. We identified that male
athletes returned-to-academics a median of 2 days sooner than female athletes. Further, 15.8% of males and 20.7% of females had still not returned-to-academics at 3 weeks (21 days) post-injury, and 11.2% of males’ and of 14.9% females’ return persisted beyond 4 weeks (28 days) post-injury. Whether a 1- or 2-day difference in the time to academic, or athletics, return is considered clinically meaningful is not something that, to our knowledge, has been thoroughly discussed in the literature. Consider, for instance, the impact on the injured athlete who may miss an athletic or scholastic event (e.g., exam, competition) as they refrained from activities 1 or 2 more days. More broadly, this study demonstrated that significant proportions of collegiate athletes show academic return 3 or more weeks beyond injury, and male collegiate athletes were returning to academics at a faster pace than females. Coupled with past research showing similar patterns of greater symptom burden\textsuperscript{16-18} and duration,\textsuperscript{16,19-22} as well as research showing worse academic performance in female athletes compared to male athletes following a SRC,\textsuperscript{23} we suggest that this prolonged symptom burden likely impacts the ability to be in an academic environment resulting in greater class time missed. The sex differences in academic return, as well as the variability across sports, shown in this large sample also supports the development and use of gradual return-to-academic protocols, similar to gradual return-to-activity protocols already in use,\textsuperscript{4} in collegiate student-athletes.\textsuperscript{24} Specifically, a return-to-academics progression for collegiate student athletes that includes initial cognitive rest, gradual reintroduction of cognitive activity, gradual reintegration into academics and a resumption of a full cognitive workload\textsuperscript{24} would be helpful in returning athletes to class successfully.

Our study found no differences in the overall sample for the time to return to limited and full activity between males and females. There were differences in time to return when looking at individual sports, but these do not seem to be associated with sex. These findings are consistent with other studies within the Ivy League examining sex differences in the time to return to activity. For example, Davis-Hayes et al.\textsuperscript{25} reported similar return to play time following SRC between male and female athletes participating in Columbia University athletics over 15
years. Putukian and colleagues\textsuperscript{14} found no differences in time to return to competition in male and female athletes across four collegiate sports (i.e., basketball, soccer, rugby, water polo). However, it should be noted that other studies have reported sex differences in time to return to play, although the generalizability of these studies have been limited by small sample sizes. In particular, one study showed that female collegiate soccer athletes who sustained an SRC in practice took longer to return to play compared to males, while female collegiate basketball athletes who sustained an SRC in competition took longer to return to play than males.\textsuperscript{11} These findings, coupled with the results of the current study, highlight the importance of evaluating not only male versus female differences in clinical recovery outcomes, but also patterns of clinical recovery outcomes within sports. For example, in men’s and women’s lacrosse, there are rule, equipment, and style of play differences within the game that all have potential to influence a student-athletes’ recovery from SRC.\textsuperscript{15}

This study presented recovery trajectories across sports for male and female athletes from the Ivy League as part of a large, multi-site study. Importantly, this is one of the first studies to show that in the absence of sex differences in the time to return-to-activity, male and female athletes show significant differences in the time for symptom resolution and return-to-academics. Although this study was not able to account for how premorbid differences in symptom presentation between males and females impacted SRC outcomes, which is an important consideration given past studies showing sex differences in premorbid symptom presentation,\textsuperscript{12,26-28} we do show that female athletes demonstrate protracted symptom resolution across sports. Furthermore, our results show that across recovery time points, a greater proportion of female athletes still had not returned to class. It may be the case that greater symptom burden in females is a mechanism underlying the protracted return-to-academics. Future research should examine athletes who present with greater symptom burden take longer to return to academics, and moreover, whether specific symptom profiles predict who will benefit from gradual return-to-academic protocols and school accommodations.
Limitations

Our study provides important information, particularly with respect to return-to-academics in collegiate athletes, yet some important limitations must be considered. The sample was drawn from schools within the Ivy League who have access to a similar standard of care. Past studies have shown that standard of care and access to athletic trainers can significantly impact recovery time in athletes. Further, although reported for adolescent athletes, athletes who are able to access specialty care earlier, particularly for female athletes, have faster recovery times.\textsuperscript{13} Similarly, the Ivy League includes schools that must follow strict SRC management protocols, that includes immediate removal from sport when a concussion is suspected. Past studies have shown that immediate removal from sport results in less time missed from sport and shorter symptom duration\textsuperscript{29} and that continuing to play after injury have longer recovery times.\textsuperscript{30} These results may not be generalizable to other schools, competitive levels and divisions that may have more limited access to care and less stringent concussion identification and management protocols. In addition, the findings within this sample may not translate directly to older, or younger populations, or to athletes in other athletic conferences. With so many sports, which is a strength of this study, we were in a position to decide whether and how to adjust p-values and set a threshold for statistical significance. We did not set a threshold here, and instead simply report the p-value for each analysis in the supplemental tables, and focus instead on the estimates themselves, given that our goal is to inform considerations over whether women and men athletes in a given sport experience recovery times that differ to an extent that is clinically meaningful. Smaller cell sizes, which will generally inflate p-values, are an inevitability when reporting many subgroup analyses. In addition, our study did not include whether student athletes had access to academic accommodations or completed a gradual return-to-academics protocols. Given that gradual return-to-learn is a relatively new recommendation,\textsuperscript{4} it is likely that athletes in the sample completed this, particularly for SRCs reported in earlier years. Furthermore, we did not aim to account for...
premorbid symptoms or factors that may have impacted symptoms post-injury, given our aim to simply report on the experience of athletes rather than to investigate and report characteristics associated with variability in timelines to recovery. However, we did evaluate the influence of previous concussion history on recovery in males and females. Both males and females with a greater number of previous concussions displayed longer time to each clinical recovery outcome, yet the only significant difference that males time to return to academics males varied by number of previous concussions. These findings should motivate future studies to investigate other factors (e.g., learning disorders, neurodevelopmental disorders, and mood) that may influence recovery post-concussion.

Conclusions

This was a large multi-site study, reporting clinical recovery outcome trajectories for collegiate student-athletes of all sports across all Ivy League institutions. Female student-athletes experienced longer symptom recovery trajectories and return-to-academics compared to male student-athletes. However, we found no significant differences in return to limited or full athletic activity between male and female student-athletes. These findings support previous work that suggest a longer symptom burden in female student-athletes and is the first to evaluate if sex differences exist in return-to-academics following a SRC. Within sport comparisons yielded sex differences specifically for symptom resolution and return-to-academics in lacrosse and return-to-athletic activity in volleyball. Taken together, sex differences and limited sport-specific differences in SRC recovery trajectories further support the need for an individualized approach for clinical management of SRC. Future research should continue to evaluate progressive return-to-learn in collegiate student-athletes following SRC.
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Table 1. Student-Athlete Characteristics

|                             | Male (n = 1,209) | Female (n = 765) | P     |
|-----------------------------|------------------|------------------|-------|
|                             | M    | SD  | M    | SD  |       |
| Age, years                  | 19.96| 1.3 | 19.57| 1.2 | < 0.001 |
| Years competing in sport, years | 10.50| 4.1 | 9.32| 4.7 | < 0.001 |
| History of Previous Concussion | 0   | 562 | 382  | 49.9  | 0.268 |
|                            | 1    | 354 | 211 | 27.6 |
|                            | 2    | 175 | 92  | 12.0 |
|                            | ≥3   | 118 | 80  | 10.5 |
| Received academic accommodations while returning to academics, yes a | 354 | 48.8 | 281 | 57.5 | 0.003 |

a There were 761 (male: 483, female: 278) cases with missing information regarding academic accommodations.
Table 2. Concussions Stratified by Sport and Sex for Student-Athletes Participating in Ivy League Sports from 2013-14 to 2018-19 Academic Years

| Contact Classification | Sports          | Number of Concussions (n, %) | Male | Female |
|------------------------|-----------------|-----------------------------|------|--------|
|                        |                 |                             |      |        |
| Contact sports         |                 |                             |      |        |
|                        | Basketball      | 1,101                       | 93.4 | 552    |
|                        | Diving          | 5                           | 0.4  | 9      |
|                        | Field hockey    | ---                         | ---  | 59     |
|                        | American Football| 487                       | 40.3 | ---    |
|                        | Sprint football | 50                          | 4.1  | ---    |
|                        | Ice hockey      | 122                         | 10.1 | 93     |
|                        | Lacrosse        | 114                         | 9.4  | 75     |
|                        | Rugby           | 71                          | 5.9  | 134    |
|                        | Soccer          | 87                          | 7.2  | 94     |
|                        | Water polo      | 35                          | 2.9  | 30     |
|                        | Wrestling       | 96                          | 7.9  | ---    |
| Limited contact        |                 |                             |      |        |
|                        | Baseball/Softball| 26                         | 2.2  | 35     |
|                        | Fencing         | 9                           | 0.7  | 5      |
|                        | Gymnastics      | ---                         | ---  | 44     |
|                        | Track & field/Cross country | 15              | 1.2  | 12     |
|                        | Volleyball      | 4                           | 0.3  | 42     |
| Non-contact sports     |                 |                             |      |        |
|                        | Equestrian      | ---                         | ---  | 6      |
|                        | Golf            | 1                           | 0.1  | ---    |
|                        | Polo            | 1                           | 0.1  | 2      |
|                        | Rowing/crew     | 6                           | 0.5  | 8      |
|                        | Sailing         | 3                           | 0.3  | 10     |
|                        | Skiing          | 2                           | 0.2  | 6      |
|                        | Squash          | 3                           | 0.3  | 12     |
|                        | Swimming        | 8                           | 0.7  | 20     |
|                        | Tennis          | 2                           | 0.2  | 5      |
Figure 1. Kaplan-Meier survival curves for time to a. symptom resolution, b. return-to-academics, c. return-to-limited play, and d. return-to-full play stratified by sex. Median days and interquartile ranges [IQR] are presented for each clinical recovery outcome. Peto tests compared differences between sexes.
Figure 2. Percentage of male and female sport-related concussion cases with a history of one or more previous concussions, by sport.
Figure 3. Kaplan-Meier survival curves for males’ time to a. symptom resolution, b. return-to-academics, c. return-to-limited play, and d. return-to-full play, stratified by number of previous concussions. Median days and interquartile ranges [IQR] are presented for each clinical recovery outcome. Peto tests compared differences between previous concussion histories.
Figure 4. Kaplan-Meier survival curves for females’ time to a. symptom resolution, b. return-to-academics, c. return-to-limited play, and d. return-to-full play, stratified by number of previous concussions. Median days and interquartile ranges [IQR] are presented for each clinical recovery outcome. Peto tests compared differences between previous concussion histories.
### Supplemental Table 1. Symptom Resolution Time Stratified by Sex and Sport

| Contact Classification | Sport               | Sex | Number of Concussions | 7 days | 14 days | 21 days | 28 days | 35 days | Days to Symptom Resolution, Median |
|------------------------|---------------------|-----|------------------------|--------|---------|---------|---------|---------|---------------------------------|
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 60                     | 53.3   | 38.0    | 36.3    | 32.8    | 27.4    | 8      | 0.616                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 64                     | 59.4   | 39.1    | 31.3    | 28.3    | 25.0    | 10     | 0.500                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 3                      | 33.3   | 33.3    | 33.3    | 33.3    | 33.3    | 9      | 0.483                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 6                    | 66.7   | 33.3    | 33.3    | 16.7    | 9       | 0.390                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 39                    | 51.3   | 18.0    | 7.7     | 2.6     | 2.6     | 8      | 0.600                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 369                   | 50.1   | 26.0    | 15.2    | 8.4     | 3.5     | 8      | 0.900                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 39                    | 38.5   | 25.1    | 10.3    | 5.1     | 2.6     | 6      | 0.600                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 81                    | 46.2   | 25.9    | 18.5    | 13.6    | 11.1    | 7      | 0.881                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 62                    | 46.8   | 27.4    | 16.1    | 11.3    | 6.5     | 6      | 0.500                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 80                   | 50.0   | 16.3    | 11.3    | 7.5     | 6.3     | 7      | 0.030                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 62                    | 58.1   | 25.8    | 16.1    | 11.3    | 3.2     | 9      | 0.800                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 68                   | 58.8   | 30.9    | 19.1    | 13.2    | 11.8    | 9      | 0.088                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 130                  | 69.2   | 46.2    | 31.1    | 24.6    | 20.8    | 11     | 0.000                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 86                   | 68.6   | 47.7    | 39.5    | 37.2    | 34.9    | 13     | 0.215                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 91                    | 59.3   | 36.3    | 30.8    | 26.4    | 24.2    | 10     | 0.900                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 35                   | 65.7   | 51.4    | 42.9    | 37.1    | 34.3    | 10     | 0.089                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 25                    | 48.0   | 16.0    | 16.0    | 16.0    | 8.0     | 7      | 0.700                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 68                   | 63.2   | 36.8    | 23.5    | 14.7    | 5.9     | 10     | 0.800                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 26                    | 43.3   | 26.9    | 19.2    | 15.4    | 13.5    | 7      | 0.700                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 9                    | 80.0   | 40.0    | 40.0    | 40.0    | 40.0    | 34     | 0.800                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 1                     | 1      | ---     | ---     | ---     | ---     | ---    | ---                             |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 2                   | 50.0   | 50.0    | ---     | ---     | ---     | --     | ---                             |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 5                     | 40.0   | 20.0    | 20.0    | 20.0    | 20.0    | 3      | 0.325                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 8                   | 62.5   | 25.0    | 12.5    | ---     | ---     | ---    | 0.538                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 9                     | 77.8   | 33.3    | ---     | ---     | ---     | 13     | 0.541                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 2                   | 100.0  | 50.0    | ---     | ---     | ---     | 12     | 0.445                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 10                    | 50.0   | 30.0    | 20.0    | 10.0    | 6      | 5.000                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 16                  | 62.5   | 50.0    | 25.0    | 18.8    | ---     | 11     | 11.0                            |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 1                     | 100.0  | ---     | ---     | ---     | ---     | ---    | 0.480                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 3                   | 66.7   | 33.3    | ---     | ---     | ---     | 10     | 0.500                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Male| 955                   | 53.4   | 25.3    | 12.5    | 14.4    | 10.7    | 8      | 0.029                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Female| 642                  | 57.6   | 25.5    | 21.0    | 17.5    | 15.2    | 9      | 0.900                           |
|                        |                     |     |                        |        |         |         |         |         |                                 |
|                        |                     | Overall| 1,597                 | 55.1   | 30.7    | 21.2    | 15.6    | 11.7    | 9      | 8.000                           |

**Three dashes indicate 100% of athletes had full symptom resolution.**

**n/a indicates median could be calculated because there was only 1 (or no) participants.**

**Peto tests comparing males and females in sex comparable sports.**

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**Table Notes:**

- **Concussions**
- **Number of Concussions**
- **Symptom Resolution Time Stratified by Sex and Sport**
- **Proportion Symptoms Not Resolved (%)**
- **Crude Analyses p**
- **Days to Symptom Resolution, Median**
- **Days to Symptom Resolution, Median, by Number of Previous Concussions**

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**Online First**

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| Contact Classification | Sport          | Sex    | Number of Concussions | Proportion Not Returned to Academics (%) | Days to Academic Return, Median, by Number of Previous Concussions |
|------------------------|----------------|--------|------------------------|------------------------------------------|------------------------------------------------------------------|
|                        |                |        |                        | days 3 days 14 days 21 days 31 days 35 days | 0 1 or more p *                                                  |
| Contact                |                |        |                        |                                          |                                                                  |
|                        | Basketball     | Male   | 53                     | 54.7 37.7 32.1 28.2 24.2 8.0           | 0.622 10.0 0.791 7.0 0.746                                       |
|                        |                | Female | 60                     | 60.0 38.3 26.7 25.0 25.2 11.0           | 11.0 10.0                                                      |
|                        | Diving         | Male   | 3                      | 65.7 66.7 33.3 -- -- --               | 16.0 0.730 0.157 3.0 0.248                                     |
|                        |                | Female | 6                      | 66.7 16.7 16.7 -- -- --               | 8.0 5.0 14.0                                                    |
|                        | Field hockey   | Female | 40                     | 52.5 25.0 7.5 5.0 5.0 8.0             | 8.0 6.0 8.0                                                    |
|                        | Football       | Male   | 342                    | 46.5 18.1 9.9 6.7 4.4 6.0             | 7.0 7.0 6.0                                                    |
|                        |                | Female | 68                     | 66.7 16.7 16.7 -- -- --               | 8.0 5.0 14.0                                                    |
|                        | Ice hockey     | Male   | 85                     | 45.9 20.0 10.6 5.9 3.5 7.0           | 7.0 0.794 7.0 0.969 6.0 0.714                                   |
|                        |                | Female | 66                     | 37.9 21.2 15.2 7.6 6.1 5.0           | 5.0 5.0 14.0                                                    |
|                        | Lacrosse       | Male   | 90                     | 47.8 18.9 11.1 7.8 4.4 7.0           | 7.0 0.055 5.0 0.210 9.0 0.107                                   |
|                        |                | Female | 50                     | 61.0 20.0 8.0 4.0 2.0 9.0           | 9.0 8.0 10.0                                                    |
|                        | Rugby          | Male   | 40                     | 62.5 45.0 35.0 27.5 25.0 10.0         | 10.0 0.580 10.0 0.387 9.0 0.996                                 |
|                        |                | Female | 106                    | 67.9 46.2 37.7 30.2 28.3 12.0         | 12.0 16.0 9.0                                                   |
|                        | Soccer         | Male   | 82                     | 48.8 36.6 34.2 36.2 32.9 7.0          | 7.0 0.465 8.0 0.300 7.0 0.978                                   |
|                        |                | Female | 82                     | 51.2 31.7 26.8 23.2 23.2 8.0          | 8.0 6.0 8.0                                                    |
|                        | Water polo     | Male   | 34                     | 44.1 29.4 20.6 11.8 8.8 6.0           | 6.0 0.372 6.0 0.417 5.0 0.540                                   |
|                        |                | Female | 34                     | 45.8 16.7 11.5 12.5 12.5 7.0          | 7.0 5.0 7.0                                                    |
|                        | Wrestling      | Male   | 73                     | 58.9 32.9 20.6 12.3 6.9 9.0         | 9.0 7.0 11.0                                                    |
|                        |                | Female | 584                    | 60.0 20.7 14.9 9.3 7.0 1.05           | 11.0 11.0 11.0                                                 |
|                        |                |        |                        |                                          |                                                                  |
| Limited contact        |                |        |                        |                                          |                                                                  |
|                        | Baseball       | Male   | 19                     | 21.1 15.8 -- -- -- --                 | 5.0 0.001 4.0 0.067 5.0 0.014                                   |
|                        |                | Female | 25                     | 76.0 24.0 12.0 4.0 4.0 9.0           | 9.0 9.0 16.0                                                    |
|                        | Fencing        | Male   | 5                      | 20.0 20.0 20.0 20.0 20.0 20.0         | 5.0 0.846 2.0 0.430 n/a                                        |
|                        |                | Female | 3                      | -- -- -- -- -- -- -- --               | 4.0 4.0 4.0 n/a                                                |
|                        | Gymnastics     | Male   | 31                     | 48.4 22.6 9.7 6.5 3.2 7.0           | 7.0 7.0 7.0                                                    |
|                        |                | Female | 13                     | 38.5 7.7 -- -- -- --                 | 4.0 0.542 5.0 0.600 2.0 0.209                                   |
|                        | Track & field/Cross country | Female | 9                      | 44.4 22.2 22.2 14.1 14.1 7.0         | 7.0 4.0 7.0                                                    |
|                        | Volleyball     | Male   | 4                      | 25.0 -- -- -- -- -- --               | 7.0 0.171 4.0 0.182 n/a                                        |
|                        |                | Female | 31                     | 41.9 19.4 12.9 6.5 6.5 7.0           | 6.0 6.0 6.0                                                    |
|                        | Squash         | Male   | 2                      | 50.0 50.0 -- -- -- --                 | 1.0 1.0 1.0 n/a                                                |
|                        |                | Female | 1                      | -- -- -- -- -- -- --                 | n/a 1.0 1.0 n/a                                                |
|                        | Equestrian     | Female | 4                      | 75.0 50.0 50.0 25.0 -- --            | 9.0 9.0 n/a 24.0                                              |
|                        | Golf           | Male   | 1                      | -- -- -- -- -- -- --                 | -- -- -- -- -- -- -- --                                        |
|                        | Polo           | Male   | 1                      | -- -- -- -- -- -- --                 | -- -- -- -- -- -- -- --                                        |
|                        |                | Female | 2                      | -- -- -- -- -- -- --                 | -- -- -- -- -- -- -- --                                        |
|                        | Rowing/crew    | Male   | 4                      | 50.0 25.0 -- -- -- --                 | 7.0 0.547 10.0 0.564 n/a 0.480                              |
|                        |                | Female | 6                      | 66.7 16.7 16.7 -- -- --               | 9.0 13.0 9.0                                                  |
|                        | Sailing       | Male   | 2                      | 100.0 100.0 100.0 100.0 100.0 80       | 80 n/a 1.0                                                    |
|                        |                | Female | 9                      | 55.6 11.1 -- -- -- --                 | 11 7.0 11.0                                                   |
|                        | Skiing        | Male   | 1                      | -- -- -- -- -- -- --                 | n/a -- -- -- -- -- -- --                                      |
|                        |                | Female | 2                      | 50.0 50.0 -- -- -- --                 | 1.0 n/a -- -- -- -- -- --                                      |
|                        | Squash        | Male   | 1                      | -- -- -- -- -- -- --                 | n/a 0.638 n/a 0.370 n/a                                      |
|                        |                | Female | 1                      | -- -- -- -- -- -- --                 | n/a 1.0 1.0 n/a                                                |
|                        | Swimming      | Male   | 6                      | 50.0 33.3 14.9 -- -- --               | 7.0 0.165 9.0 0.272 n/a                                        |
|                        |                | Female | 15                     | 78.1 -- -- -- -- -- --                | 14.0 11.0 14.0                                                |
|                        | Tennis        | Male   | 2                      | 50.0 50.0 50.0 -- -- --               | 5.0 1.000 n/a 0.655 n/a                                       |
|                        |                | Female | 5                      | 60.0 20.0 -- -- -- --                 | 11.0 11.0 n/a                                                 |
|                        |                  | Total | 872                    | 50.0 24.0 13.8 12.9 12.9 9.3          | 7.0 < 0.001 6.0 < 0.001 7.0 0.015                              |
|                        |                  | Female | 584                    | 51.5 22.3 20.7 14.9 13.5 9.0          | 9.0 8.0 9.0                                                    |
|                        |                  | Overall | 1,456                  | 50.0 24.0 13.8 12.9 12.9 9.3          | 7.0 < 0.001 6.0 < 0.001 7.0 0.015                              |

Three dashes indicate 100% of athletes had full symptom resolution.

n/a indicates median could be calculated because there was only 1 (or no) participants.

* Peto tests comparing males and females in sex comparable sports.
### Supplemental Table 3. Return to Limited Athletics Stratified by Sex and Sport

| Contact Classification | Sport               | Sex  | Number of Concussions | Proportion Not Returned to Limited Play (%) | Days to Limited Return, Median | Days to Limited Return, Median, by Number of Previous Concussions |
|------------------------|---------------------|------|------------------------|--------------------------------------------|-------------------------------|---------------------------------------------------------------|
|                        |                     |      |                        |                                            |                               | p *                                                                 |
|                        |                     |      |                        |                                            |                               | p *                                                                 |
|                        |                     |      |                        |                                            |                               | 1 more                                                          |
|                        |                     |      |                        |                                            |                               |                                                                 |
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| Sport                      | Male | Female | Number of Concussions | Crude Analyses | Days to Full Return, Median | Days to Full Return, Crude Analyses Mean | Days to Full Return, Median by Number of Previous Concussions | Number of Concussions | Crude Analyses | Days to Full Return, Median | Days to Full Return, Crude Analyses Mean | Days to Full Return, Median by Number of Previous Concussions |
|----------------------------|------|--------|-----------------------|----------------|-----------------------------|------------------------------------------|------------------------------------------|----------------------|----------------|-----------------------------|------------------------------------------|------------------------------------------|
| Basketball                 | 60   | 10     | 83.3                  | 53.7           | 36.7                        | 24.6                                     | 18.6                                     | 16.0                 | 0.354          | 13.0                        | 0.823                                    | 20.0                                     | 0.113 |
| Diving                     | 64   | 17     | 79.7                  | 45.3           | 28.1                        | 17.2                                     | 15.6                                     | 13.0                 | 17.0           | 13.0                        | 0.270                                    | 20.0                                     | 0.036 |
| Field hockey               | 6    | 2      | 100.0                 | 66.7           | 33.3                        | 16.7                                     | 16.7                                     | 16.0                 | 16.0           | 11.0                        | 0.287                                    | 15.0                                     | 0.123 |
| Football                   | 4    | 1      | 100.0                 | 25.0           | 25.0                        | —                                       | —                                       | 13.0                 | 0.855          | 13.0                        | 0.094                                    | n/a                                      | 0.248 |
| Ice hockey                 | 5    | 2      | 100.0                 | 86.1           | 47.2                        | 30.6                                     | 19.4                                     | 8.3                  | 14.0           | 13.0                        | 0.287                                    | 15.0                                     | 0.783 |
| Lacrosse                   | 3    | 1      | 100.0                 | 79.6           | 48.4                        | 25.8                                     | 18.3                                     | 14.0                 | 0.208          | 13.0                        | 0.392                                    | 17.0                                     | 0.407 |
| Male                       | 61   | 1      | 93.4                  | 55.7           | 36.1                        | 26.3                                     | 23.0                                     | 16.0                 | 13.0           | 19.0                        | n/a                                      | n/a                                      | n/a  |
| Rugby                      | 63   | 1      | 95.2                  | 68.3           | 49.2                        | 39.7                                     | 39.7                                     | 21.0                 | 0.150          | 20.0                        | 0.408                                    | 23.0                                     | 0.557 |
| Male                       | 128  | 3      | 94.5                  | 76.6           | 66.4                        | 54.7                                     | 48.4                                     | 34.0                 | 33.0           | 85.0                        | n/a                                      | n/a                                      | n/a  |
| Soccer                     | 87   | 2      | 83.9                  | 56.3           | 42.5                        | 35.6                                     | 31.0                                     | 17.0                 | 0.441          | 13.0                        | 0.132                                    | 19.0                                     | 0.067 |
| Water polo                 | 35   | 1      | 88.6                  | 57.1           | 37.1                        | 25.7                                     | 22.9                                     | 18.0                 | 0.579          | 16.0                        | 0.161                                    | 18.0                                     | 0.181 |
| Volleyball                 | 27   | 2      | 81.5                  | 44.4           | 25.0                        | 16.7                                     | 12.5                                     | 13.0                 | 13.0           | 21.0                        | n/a                                      | n/a                                      | n/a  |
| Wrestling                  | 82   | 2      | 92.7                  | 72.0           | 45.1                        | 35.4                                     | 23.2                                     | 18.0                 | 17.0           | 22.0                        | n/a                                      | n/a                                      | n/a  |
| Non-contact                |      |        |                       |                |                             |                                          |                                          |                      |                |                             |                                          |                                          |      |
| Equestrian                | 5    | 1      | 100.0                 | 60.0           | 60.0                        | 40.0                                     | 25.0                                     | 14.0                 | 0.450          | 14.0                        | 0.950                                    | 11.0                                     | 0.271 |
| Golf                       | 1    | 0      | 100.0                 | —              | —                           | —                                        | —                                        | n/a                  | n/a            | n/a                         | n/a                                      | n/a                                      | n/a  |
| Polo                       | 5    | 1      | 100.0                 | —              | —                           | —                                        | —                                        | n/a                  | n/a            | n/a                         | n/a                                      | n/a                                      | n/a  |
| Female                     | 1    | 0      | 100.0                 | —              | —                           | —                                        | —                                        | n/a                  | n/a            | n/a                         | n/a                                      | n/a                                      | n/a  |
| Male                       | 4    | 1      | 100.0                 | 50.0           | 50.0                        | 50.0                                     | 25.0                                     | 7.0                  | 34.0           | n/a                         | n/a                                      | n/a                                      | n/a  |
| Male                       | 40   | 5      | 90.0                  | 57.5           | 40.0                        | 32.5                                     | 20.0                                     | 17.0                 | 0.853          | 14.0                        | 0.245                                    | 18.0                                     | 0.760 |
| Male                       | 13   | 1      | 100.0                 | 69.2           | 23.1                        | 15.4                                     | 15.4                                     | 13.0                 | 0.683          | 16.0                        | 0.243                                    | 18.0                                     | 0.424 |
| Female                     | 10   | 1      | 100.0                 | 75.0           | 40.0                        | 20.0                                     | —                                       | 21.0                 | 0.527          | 16.0                        | 0.161                                    | 18.0                                     | 0.181 |
| Male                       | 4    | 1      | 50.0                  | 25.0           | 25.0                        | 25.0                                     | 25.0                                     | 7.0                  | 0.049          | 7.0                         | 0.011                                    | n/a                                      | n/a  |
| Female                     | 28   | 2      | 85.7                  | 46.4           | 25.0                        | 17.7                                     | 7.4                                      | 13.0                 | 15.0           | 16.0                        | n/a                                      | n/a                                      | n/a  |
| Non-contact                |      |        |                       |                |                             |                                          |                                          |                      |                |                             |                                          |                                          |      |
| Squash                     | 2    | 2      | 100.0                 | 100.0          | 100.0                       | 100.0                                    | 100.0                                    | 19.0                 | 0.345          | 19.0                        | 0.345                                    | 19.0                                     | 0.345 |
| Swimming                   | 9    | 1      | 88.9                  | 65.0           | 40.0                        | 22.2                                     | 22.2                                     | 15.0                 | 10.0           | 16.0                        | n/a                                      | n/a                                      | n/a  |
| Female                     | 8    | 1      | 75.0                  | 62.5           | 50.0                        | 37.5                                     | 37.5                                     | 12.5                 | 13.0           | 29.0                        | n/a                                      | n/a                                      | n/a  |
| Male                       | 20   | 1      | 95.0                  | 60.0           | 40.0                        | 30.0                                     | 25.0                                     | 21.0                 | 0.578          | 14.0                        | 0.413                                    | 16.0                                     | 0.984 |
| Male                       | 6    | 1      | 100.0                 | 50.0           | 50.0                        | 50.0                                     | 50.0                                     | 14.0                 | 0.450          | 14.0                        | 0.088                                    | n/a                                      | n/a  |
| Male                       | 810  | 8      | 85.7                  | 33.7           | 37.0                        | 26.7                                     | 21.4                                     | 17.0                 | 16.0           | 18.0                        | n/a                                      | n/a                                      | n/a  |
| Male                       |      |        |                       |                |                             |                                          |                                          |                      |                |                             |                                          |                                          |      |
| Overall                    | 1,140| 9      | 84.3                  | 46.4           | 28.2                        | 19.6                                     | 14.8                                     | 15.0                 | 0.578          | 14.0                        | 0.413                                    | 16.0                                     | 0.984 |
| Three dashes indicate 100% of athletes returned to full participation. n/a indicates median could be calculated because there was only 1 (or no) participants.

* Peto tests comparing males and females in sex-stratified subgroups.