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Concussion Recovery Timeline of High School Athletes Using A Stepwise Return-to-Play Protocol: Age and Sex Effects

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Context: Implementation of a stepwise return-to-play (RTP) protocol has become the standard management strategy for high school athletes to ensure a safe RTP after concussion. The detailed characteristics of the recovery timeline throughout the steps of an RTP protocol have not been delineated among the adolescent population.

Objective: To investigate the days spent in each step of the stepwise RTP protocol in an adolescent population and examine the effects of age and sex on recovery time.

Design: Cross-sectional study.

Setting: Local schools.

Patients or Other Participants: Student-athletes from 57 schools.

Intervention(s): A total of 726 patients with concussion (age = 15.5 ± 1.2 years, males = 454, females = 272) were included. The 7-step RTP protocol consists of the following steps: (1) complete cognitive rest, (2) full return to school, (3) light exercise, (4) running progression, (5) noncontact training drills and weight training, (6) full-contact practice or training, and (7) return to game play. The data were obtained by certified athletic trainers as a part of the statewide standardized concussion-management protocol.

Main Outcome Measure(s): Days spent in steps 0 to 6 as well as a breakdown of days by sex and age.

Results: The average total RTP days were 20.2 ± 13.9. Half of this time was spent in the return-to-school phase (steps 2–3: 10.2 ± 10.0 days). Compared with 17-year-old participants, younger participants (age = 14–16 years) took 3 or 4 days longer to start step 3 and to reach step 6 ($P < .05$). Females took longer to reach step 6 than males (21.6 ± 15.5 versus 19.3 ± 12.7 days) because they took longer to reach step 3 (14.7 ± 11.4 days) than males (13.0 ± 10.0 days; $P < .05$).

Conclusions: Our study provides an estimated stepwise concussion recovery timeline for adolescent student-athletes. Clearance to start step 3 was the benchmark for the recovery timeline, as the duration of the exercise portion of the protocol was consistent across the age and sex groups.

Key Words: mild traumatic brain injury, return to sport, adolescents

Key Points

- The average total time for full clearance (step 6) was 20.2 ± 13.9 days, and half of this time was spent in the returning-to-school phase (steps 2–3 = 10.2 ± 10.0 days).
- The younger student athletes (age = 14–16 years) took 3 to 4 days longer to start step 3 and to reach step 6 than those aged 17 years.
- Compared with males, females took longer to reach step 6 (21.6 ± 15.5 days versus 19.3 ± 12.7 days), most likely because they took longer to reach step 3 (14.7 ± 11.4 days versus 13.0 ± 10.0 days).
- The duration of the exercise portion of the return-to-play protocol (steps 3–6) was consistent across the age and sex groups.

The 2016 Berlin consensus statement[1] advocated a graduated stepwise approach for safely returning patients to sport participation after concussion. This protocol consists of 6 steps from the onset of injury to return to game play: (1) symptom-limited activity, (2) light aerobic exercise, (3) sport-specific exercise, (4) noncontact training drills, (5) full-contact practice, and (6) return to sport without restrictions. Patients proceed to each subsequent step once they become asymptomatic at the current step; if they become symptomatic within 24 hours of performing the required physical exercises at a step, they drop back to the previous step.[1] The key is to ensure that the patient remains asymptomatic at each step to avoid symptom aggravation and delayed recovery.[1,2] An initial rest period during the acute symptomatic phase seems to be beneficial,[3] and a gradual return to school and social activities during the no-activity period (step 1) is recommended. The guidelines provide clinicians with a solid basis for a standardized postconcussion-management protocol.

In their recent systematic review, Haider et al[4] reported that in 43 of 2023 publications, 2 or more measures were

Table 1. The 7-Step Gradual Return-to-Play Postconcussion Protocol[a]

Step	Description	Definition
Onset	Onset	Date concussion occurred
1	Cognitive rest	Date athletic trainer counsels or student-athlete initiates cognitive rest
2	Full return to school	Date student-athlete returns to school full time; school adjustments may be provided at this time
3	Light aerobic activity	Date athlete is able to start light aerobic activity without symptoms (stationary bike or timed run) and has completed all of the following: • Medical clearance • Normal results on ImPACT[b] compared with baseline or norm • Normal results on Balance Error Scoring System compared with baseline • No school adjustments or accommodations being provided • Asymptomatic for at least 24 hours
4	Running and sport-specific drills	Date athlete is able to perform individual strenuous running and sprints and individual noncontact sport-specific drills without symptoms
5	Noncontact drills	Date athlete is able to perform team noncontact and sport-specific drills without symptoms
6	Full-contact practice	Date athlete is able to perform a full day of full-contact practice without symptoms
7	Return to game	Date athlete may participate without limitations and is discharged

[a] Step 1 in the 2009 consensus statement[7] was divided into 2 steps.
[b] ImPACT Applications, Inc, San Diego, CA.

used to determine recovery. Their results suggested inconsistency in the definition of *concussion recovery*, which may have contributed to the wide range of reported recovery times. For example, Kerr et al[5] indicated that 35.4% (294/830) of high school football players returned to play in 7 to 13 days, whereas McCrea et al[6] observed that 85.4% of high school and college athletes reported full symptom recovery within 1 week, including 21.1% within the first day. Using the graduated return-to-sport guidelines,[1] Kerr et al[5] described the duration to reach step 5 (full-contact practice) or 6 (return to sport), whereas McCrea et al[6] measured the duration to complete step 1 (symptom-limited activity). Although researchers can operationally define *recovery* for their study purpose, inconsistent definitions could lead to miscommunication in the practical setting. For example, *recovery* as described by a physician could mean *symptom recovery* (ie, completion of step 1), whereas athletes and parents could interpret it as *return to play* (ie, step 5 or 6). In the practical setting, especially when the patient's goal is to return to sport or physical activities, it is critical to clarify each *recovery* definition with respect to the specific step of a graduated protocol.

Clinicians must understand the recovery timeline in relation to the graduated, stepwise protocol. However, to our knowledge, no authors have reported an overall timeline for postconcussion recovery using the graduated, stepwise protocol. Therefore, our objective was to provide a comprehensive postconcussion graduated stepwise recovery timeline for adolescent student-athletes.

METHODS

Setting

This study involved retrospective analyses of data from adolescent athletes at 57 public and private schools who sustained concussions during the 2010 through 2012 school years. Athletic trainers (ATs) at participating schools assessed all reported concussions using a standardized concussion-management protocol and were familiarized with data-collection and -reporting procedures. Student-athletes and their parents or guardians were asked to complete informed consent forms at the beginning of the season, and a patient's data were included in the analyses only if he or she sustained a concussion and informed consent had been provided. This study was approved by the university human studies program (CHS#18431).

The Standardized Concussion-Management Protocol

The standardized concussion-management protocol consisted of the graded symptom checklist (GSC), Balance Error Scoring System (BESS), Immediate Postconcussion Assessment And Cognitive Testing (ImPACT; ImPACT Applications, Inc, San Diego, CA), a 7-step graduated return-to-play (RTP) protocol (7-step RTP), and a concussion-management program (CMP) log or a sports injury-management system (SIMS; FlanTech, Inc, Iowa City, IA). The CMP log and SIMS injury-tracking systems were maintained and reported by the school's AT(s), which allowed researchers to collect data from participating schools in a uniform manner.

The GSC was administered at the time of injury using a paper-and-pencil method. It was also administered daily or at the discretion of the AT during follow-up visits. A baseline BESS measure for each athlete was video recorded and stored on an external hard drive at the onset of participation. The ATs at each school were instructed to administer the postinjury BESS at 0 to 72 hours and days 3, 5, and 7 and to continue until the BESS score equaled or was lower than the baseline score. All student-athletes participating in contact and collision sports were advised to complete the baseline ImPACT at the onset of participation during their 9th- and 11th-grade seasons. The ATs at each school were asked to administer the postinjury ImPACT at 0 to 72 hours and days 5 and 7 and to continue to do so no more than twice a week until the patient was cleared by the neuropsychologist. The ATs at participating schools followed these guidelines as closely as their schedules allowed.

The 7-step RTP was adopted from the graduated return-to-play protocol published in the 2009 consensus statement.[7] Step 1 in the graduated return-to-play protocol (no activity) was divided into 2 phases, complete cognitive rest (step 1) and full return to school (step 2), making this a 7-step RTP (Table 1). The *full return to school* was defined as

Table 2. Sex Difference in Days to Advance Through Return-to-Play Postconcussion Protocol

Sex	No.	Age, y	Return-to-Play Steps, d (Mean ± SD)								Total, d
			0–1	1–2	2–3	3–4	4–5	5–6	0–3	3–6	
Males	454	15.5 ± 1.2	0.8 ± 1.3	2.3 ± 2.6	9.9 ± 9.7	1.8 ± 2.3	2.0 ± 2.0	2.5 ± 5.2	13.0 ± 10.0	6.3 ± 6.0	19.3 ± 12.7
Females	272	15.5 ± 1.2	0.7 ± 1.4	3.2 ± 3.6	10.8 ± 10.4	2.0 ± 2.7	2.8 ± 7.9	2.1 ± 2.8	14.7 ± 11.4[a]	7.0 ± 8.9	21.6 ± 15.5[b]
Total	726	15.5 ± 1.2	0.8 ± 1.3	2.6 ± 3.0	10.2 ± 10.0	1.9 ± 2.5	2.3 ± 5.1	2.4 ± 4.4	13.6 ± 10.6	6.5 ± 7.2	20.2 ± 13.9

[a] Difference between males and females ($P = .045$).
[b] Difference between males and females ($P = .028$).

full participation in all classes without academic adjustments or accommodations, except for physical education class. The aim of this modification was to differentiate the phase of complete cognitive rest (in which the patient rests at home with minimal physical and cognitive stress) from the phase of returning to school (in which the student-athlete experiences activities of daily living and higher levels of cognitive stress). However, we did not define or collect information on the type of school adjustments or accommodations given to the athletes with concussions. The progression criteria were the same as in the graduated stepwise protocol described in the 2009 consensus statement[7]; the patient proceeded to the next step if asymptomatic for 24 hours, as assessed via GSC, but dropped back to the previous step if any postconcussion symptoms occurred. During data collection (2010–2012), the consensus was that one should be completely symptom free to start physical activities; therefore, to ensure a safe progression, additional criteria to proceed to step 3 (light exercise) were (1) physician's clearance, (2) ImPACT and BESS scores returning to baseline levels (or to the normative scores for age and sex if the athlete did not have baseline testing), and (3) full return to school with no adjustments or accommodations. A single neuropsychologist who was trained in ImPACT interpretation and specialized in concussion management interpreted all ImPACT posttest scores.

A student-athlete who was diagnosed with a concussion by the AT or team physician was referred for further medical follow-up with his or her primary care physician or concussion specialists. The AT initiated the standardized concussion-management protocol and documented the date of completion of each step according to the 7-step RTP using the CMP log or SIMS, which was then submitted to the research team.

Data Analysis

Because the completion of step 7 (return to full participation or game) could be affected by the game schedule, which might not accurately reflect the days lost due to concussion symptoms (eg, if the patient clears step 6 on Monday, but the game is not until Friday), the timeline from initial evaluation by an AT (step 0) to step 6 (full-contact practice or training) was included in the data analysis. Duration (days) for each step of the RTP and the total days lost from concussion to full participation (total RTP days) for each participant were calculated. A 2-way analysis of variance (ANOVA) was conducted to examine the sex-by-age interaction effects, and we followed up with appropriate post hoc analyses. For all data analyses, SPSS (version 20.0; IBM Corp, Amonk, NY) was used with the α level set at $P < .05$.

RESULTS

During the 2010–2012 academic years, a total of 1883 concussions were reported among 57 schools. The initial data screening was completed based on the inclusionary criteria of (1) completion of all 7 steps as indicated by the date of completion for each step, (2) completion of ImPACT or SAC and BESS assessments as indicated by the test dates and scores, and (3) athletes with a single concussion. After the initial screening, more than 50% of the data were excluded, mostly due to all 7 steps not being completed. Outlier data were excluded if the sport's season ended before completion of step 6. We investigated the remaining outliers for data accuracy by contacting the school ATs to confirm whether those step dates reflected actual concussion symptoms or noncompliance of the student-athlete. After the data screening, data from 726 concussions (mean age = 15.5 ± 1.2 years, males = 454, females = 272) were included in the subsequent analysis (Table 2).

The total RTP days (steps 0–6) were 20.2 ± 13.9 days. The days to become asymptomatic and obtain medical clearance for light exercise (steps 0–3) were 13.6 ± 10.6 days, whereas the days to complete the exercise-progression portion of the RTP protocol (steps 3–6) were 6.5 ± 7.2 days. Average days spent between steps are listed in Table 2. The 12- (n = 2), 13- (n = 18), and 18- (n = 25) year age groups were excluded from the interaction analysis due to inadequate sample sizes. A 2-way ANOVA indicated main effects of sex ($P = .048$) and age ($P = .013$), with no interactions ($P = .36$) between sex and age (14, 15, 16, and 17 years).

Tukey post hoc analysis revealed that the total RTP days for the age group of 17 years (17.0 ± 14.3 days) were different from those of age groups 14 (21.7 ± 15.6 days), 15 (21.4 ± 12.4 days), and 16 (21.4 ± 14.5 days) years, indicating that younger age groups took longer to RTP compared with age group 17 years (versus 14 years: $P = .029$, 95% confidence interval [CI] = 0.3, 9.0 days; versus 15 years: $P = .033$, 95% CI = 0.2, 8.6 days; versus 16 years: $P = .030$, 95% CI = 0.3, 8.5 days). A similar age effect was present for the days to start light aerobic exercise (steps 0–3): younger age groups (14 years: 14.6 ± 11.2 days, 15 years: 15.1 ± 11.2 days, 16 years: 14.5 ± 11.0 days) took longer than the 17-year-old group (11.0 ± 9.6 days; versus 14 years: $P = .025$, 95% CI = 0.3, 7.0 days; versus 15 years: $P = .005$, 95% CI = 1.0, 7.3 days; versus 16 years: $P = .019$, 95% = CI 0.4, 6.7 days). We observed no differences in days to complete the exercise-progression portion (steps 3–6) of the RTP protocol among age groups ($P = .58$; Table 3).

A 1-way ANOVA to further analyze the sex effect when all age groups were included (N = 726), indicated that

Table 3. Age Differences in Days to Advance Through Return-to-Play Postconcussion Protocol

Age Group, y	No.	Return-to-Play Steps, d (Mean ± SD)								Total, d
		0–1	1–2	2–3	3–4	4–5	5–6	0–3	3–6	
14	145	0.7 ± 1.1	2.7 ± 3.0	11.2 ± 10.7	1.9 ± 2.3	2.3 ± 2.1	2.9 ± 7.3	14.6 ± 11.2	7.1 ± 8.0	21.7 ± 15.6
15	177	0.7 ± 1.2	2.7 ± 3.1	11.7 ± 10.6	1.8 ± 2.3	2.0 ± 2.4	2.5 ± 3.5	15.1 ± 11.2	6.3 ± 5.1	21.4 ± 12.4
16	186	0.8 ± 1.5	2.9 ± 3.4	10.9 ± 10.2	2.0 ± 2.8	2.6 ± 2.8	2.3 ± 3.9	14.5 ± 11.0	6.9 ± 6.8	21.4 ± 14.5
17	137	0.8 ± 1.4	2.4 ± 2.6	7.7 ± 9.2	1.8 ± 2.0	2.5 ± 9.6	1.7 ± 1.5	11.0 ± 9.6[a]	6.9 ± 6.8	17.0 ± 14.3[b]
Total	645	0.8 ± 1.3	2.7 ± 3.1	10.5 ± 10.3	1.9 ± 2.4	2.4 ± 5.4	2.4 ± 4.5	13.9 ± 10.9	6.0 ± 9.7	20.52 ± 14.3

[a] Difference between age 17 and ages 14, 15, and 16 years ($P < .05$).
[b] Difference between age 17 and ages 14, 15, and 16 years ($P < .05$).

females took longer than males for the total RTP (21.6 ± 15.5 days versus 19.3 ± 12.7 days, respectively; $P = .028$, 95% CI = 0.257, 4.4 days). We noted a similar sex effect on days to start light aerobic exercise (steps 0–3): females (14.7 ± 11.4 days) took longer than males (13.0 ± 10.0 days) to be cleared for step 3 ($P = .045$, 95% CI = 0.038, 3.22 days). No difference was identified between males and females in days to complete the exercise-progression portion (steps 3–6) of the RTP protocol ($P = .20$; Table 2).

DISCUSSION

To our knowledge, we are the first to describe the comprehensive recovery timeline of the RTP protocol. The retrospective analysis of 726 concussions showed that the total days to return to full-contact practice or training (step 6) were 20.2 ± 13.9 for adolescent student-athletes, whereas total days taken to start light aerobic activity (step 3) were 13.6 ± 10.6. Our step-by-step timeline analyses showed that half of the total RTP time was spent returning to school (steps 2–3: 10.2 ± 10.0 days). The highest standard deviation, which indicates the highest variability, was also observed during this step, which could have reflected individual differences in the recovery process, the type and severity of concussion, and the availability of physician appointments, ImPACT, and BESS tests. On average, student-athletes started attending school 3.4 days after the injury (onset to step 1: 0.8 ± 1.3 days, steps 1–2: 2.6 ± 3.0 days). At the time of data collection (2010–2012), no clear consensus existed for the return-to-school protocol other than "complete physical and cognitive rest" for the no-activity stage (step 1)[7]; therefore, the standardized advice given to the student-athletes with concussions and their parents during this study period was complete cognitive and physical rest until the patient became asymptomatic or felt ready to return to school. It is likely that injured student-athletes experienced aggravated or residual symptoms during the return-to-school process that contributed to the longest time between steps 2 and 3 (10.2 ± 10.0 days). Also noteworthy is the observation that once the student-athletes were cleared to start light aerobic activity (step 3), the timeline to complete the exercise portion of the RTP protocol (steps 3–6) was relatively consistent because the range of days taken to clear each step was 1.9 to 2.4 days.

Knowing this time course will allow clinicians to better communicate with schoolteachers, administrators, and coaches regarding the concussion-management plan. We did not include data associated with the type of school adjustments or accommodations provided during the return-to-school process; however, the results clearly highlight the importance of having a return-to-school concussion-management plan.

Effect of Age

Younger age has been reported as a risk factor for longer recovery,[8–12] and the majority of these authors used *high school athletes* to define the younger age group, which was compared with a group of collegiate or professional athletes. Our findings indicate that student-athletes aged 14, 15, and 16 years took 3 to 4 days longer to RTP (step 6) as well as to start light aerobic activity (step 3) compared with those aged 17 years. Given the lack of differences in the time to complete the exercise portion of the RTP protocol (steps 3–6) among age groups, we attributed the differences in recovery time among age groups to the differences in days to start the light aerobic exercise (step 3). In contrast to previous investigators, Zuckerman et al[8] used different age categories (13 to 16 years old as the younger and 18 to 22 years old as the older group) to compare recovery time frames. The younger group took 2 to 3 days longer to return to baseline neurocognitive values (on ImPACT) and total symptom score, which was consistent with our finding. Interestingly, the researchers purposefully excluded the 17-year-old athletes to clearly delineate the 2 cohorts. The large sample of our study allowed for age comparisons that suggested age 16 to 17 years may be the transition phase. McCrory et al[1] recommended a child-specific protocol for those aged 5 to 12 years and an adolescent-specific protocol for those aged 13 to 18 years; however, they also recognized the limited evidence on how age affects concussion recovery and suggested further work. According to our data, age 16 may be the upper limit of *adolescent* in terms of concussion recovery, though these findings warrant further study to validate our results. Based on our finding, we recommend using age instead of school level (high school or college) to define the independent variable when examining the effect of age on concussion.

Effect of Sex

Differences between males and females were also present in our study. Females took 21.6 ± 15.5 days to reach step 6, whereas males took 19.3 ± 12.74 days. This difference is most likely due to females taking longer to start light aerobic exercise (step 3) compared with males (14.7 ± 11.4 days versus 13.0 ± 10.0 days, respectively). Increased postconcussion symptoms and longer recovery time in females compared with males have been well documented.[8,12–14] Although direct comparisons with these results are difficult due to differences in recovery criteria, the target

age group, and the study design, our results provide additional evidence to support the existence of sex differences in concussion recovery timelines. Zuckerman et al[15] analyzed age groups similar to those in our investigation and reported that females took approximately 2 days longer to return to their baseline total symptom score, which directly agreed with our findings. Although we did not specifically assess the days to return to the baseline total symptom score, that was 1 criterion for clearing step 2. Thus, it is plausible that a delay in symptom recovery was one of the factors causing females to take longer to be cleared to start light aerobic activity (step 3). We did not demonstrate an interaction between age and sex, which suggests that this sex difference was present between 14- and 17-year-olds regardless of age.

Strengths and Limitations

One strength of this study was the presence of ATs at each school who administered the standardized data-collection procedure, which allowed daily monitoring of student-athletes with concussions and ensured the uniform implementation of the concussion-management protocol across the 57 schools. Consistent reporting by the schools' ATs in the CMP log or SIMS allowed researchers to thoroughly screen for missing data, obvious noncompliance of student-athletes, and multiple concussions. However, the limitations of this study should be considered when referencing our results or comparing our data with those of others. Although the ATs followed the protocol as closely as possible, the compliance of student-athletes and schedule availability of physician appointments, ImPACT, and BESS testing could have influenced the recovery time course. In addition, the RTP protocol used in this study was based on the 3rd consensus statement on concussion in sport[7] published in 2009; therefore, the recommendation during step 1 was "complete physical and cognitive rest." This recommendation has been updated to "daily activities that do not provoke symptoms" in the 5th Consensus Statement, which also recognized the potential benefit of early active rehabilitation.[1] Readers should be aware that our data were collected using the 3rd consensus statement guideline and exercise caution when using our data and results as reference values. With this limitation, we feel confident that our dataset was large enough to represent the postconcussion graduated stepwise recovery timeline for adolescent student-athletes.

CONCLUSIONS

Our study provides an estimated timeline for adolescent student-athletes' concussion recovery and progression through a stepwise RTP protocol. The total RTP days (step 6) were 20.2 ± 13.9 days, and half of this time was spent in the return-to-school phase (steps 2–3: 10.2 ± 10.0 days). A return-to-school management plan is the key concussion-recovery phase for adolescent student-athletes. Clearance to start light aerobic exercise (step 3) could be the benchmark for the recovery timeline as the exercise portion of the RTP protocol was consistent across the sex and age groups.

REFERENCES

1. McCrory P, Meeuwisse W, Dvorak J, et al. Consensus statement on concussion in sport—the 5th International Conference on Concussion in Sport held in Berlin, October 2016. *Br J Sports Med*. 2017;51(11):838–847.
2. Johnston KM, Bloom GA, Ramsay J, et al. Current concepts in concussion rehabilitation. *Curr Sports Med Rep*. 2004;3(6):316–323.
3. McCrory P, Meeuwisse WH, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med*. 2013;47(5):250–258.
4. Haider MN, Leddy JJ, Pavlesen S, et al. A systematic review of criteria used to define recovery from sport-related concussion in youth athletes. *Br J Sports Med*. 2017;52(18):1179–1190.
5. Kerr ZY, Zuckerman SL, Wasserman EB, et al. Concussion symptoms and return to play time in youth, high school, and college American football athletes. *JAMA Pediatr*. 2016;170(7):647–653.
6. McCrea M, Guskiewicz K, Randolph C, et al. Effects of a symptom-free waiting period on ciinical outcome and risk of reinjury after sport-related concussion. *Neurosurgery*. 2009;65(5):876–883.
7. McCrory P, Meeuwisse W, Johnston K, et al. Consensus statement on concussion in sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *J Athl Train*. 2009;44(4):434–448.
8. Zuckerman SL, Lee YM, Odom MJ, Solomon GS, Sills AK. Recovery from sports-related concussion: days to return to neurocognitive baseline in adolescents versus young adults. *Surg Neurol Int*. 2012;3:130.
9. Pellman EJ, Viano DC, Casson IR, Arfken C, Fever H. Concussion in professional football: players returning to the same game, part 7. *Neurosurgery*. 2005;56(1):79–92.
10. McCIincy MP, Lovell MR, Pardini J, Collins MW, Spore MK. Recovery from sports concussion in high school and collegiate athletes. *Brain Inj*. 2006;20(1):33–39.
11. Field M, Collins MW, Lovell MR, et al. Does age play a role in recovery from sports-related concussion? A comparison of high school and collegiate athletes. *J Pediatr*. 2003;142(5):546–553.
12. Covassin T, Elbin RJ, Harris W, Parker T, Kontos A. The role of age and sex in symptoms, neurocognitive performance, and postural stability in athletes after concussion. *Am J Sports Med*. 2012;40(6):1303–1312.
13. Davis-Hayes C, Gossett JD, Levine WN, et al. Sex-specific outcomes and predictors of concussion recovery. *J Am Acad Orthop Surg*. 2017;25(12):818–828.
14. D'Lauro C, Johnson BR, McGinty G, Allred CD, Campbell DE, Jackson JC. Reconsidering return-to-play times: a broader perspective on concussion recovery. *Orthop J Sports Med*. 2018;6(3):2325967118760854.
15. Zuckerman SL, Apple RP, Odom MJ, Lee YM, Solomon GS, Sills AK. Effect of sex on symptoms and return to baseline in sport-related concussion. *J Neurosurg Pediatr*. 2014;13(1):72–81.

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