Academic Accommodations for a Countywide Concussion High School Program

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Authors: Ashley D. Lopez, M.S.; Michelle Shnayder; Bryan Pomares, M.H.S.; Jonathan Siegel; Kester Nedd, D.O.; Gillian Hotz, Ph.D.

Corresponding Author:
Gillian Hotz, Ph.D.
1095 NW 14th Ter
Miami, FL 33136
ghotz@med.miami.edu
302-243-4004

Gillian A. Hotz, PhD is a research professor at the University Of Miami Miller School Of Medicine and a nationally recognized behavioral neuroscientist and expert in pediatric and adult neurotrauma, concussion management, and neurorehabilitation. Dr. Hotz is the director of the KiDZ Neuroscience Center, WalkSafe and BikeSafe programs, and has been co-director of the Miller School of Medicine's Concussion Program since 1995. She continues to assess and treat many athletes from Miami-Dade County public and private high schools, University of Miami, and from other colleges and the community.
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ABSTRACT

Purpose

To describe a symptom-based distribution of Return to Learn school academic accommodations for adolescent student-athletes recovering from sports-related concussions that can be facilitated as part of their post-injury clinical care. The aim was also to explore demographic and recovery differences between those patients who received and did not receive accommodations.

Method
Adolescent student-athletes from 35 public high schools were eligible for this study. Data collected included their demographics, clinical assessment, and ImPACT (ImPACT Applications, Inc.) testing performance prior to and following a concussion. Student-athletes receiving accommodations were compared with an age-matched comparison group that did not receive accommodations.

Results
Between January 2014 and January 2017, 308 Miami-Dade County public high school student-athletes were seen at the University of Miami's UConcussion Clinic. Of these, 72 received school accommodations and 236 did not. The first clinical visit for these athletes was a mean of 14 days post injury with mean recovery time and return to play of 25 days. Significant differences were found among female student-athletes as well as patients reporting more initial symptoms despite similar demographics and baseline ImPACT scores.

Conclusions
Concussed adolescent student-athletes, particularly females, reporting greater symptom complaints during their first clinical encounter, may benefit most from a collaborative treatment approach including school accommodations that are individualized and specifically targeted. Future research should continue to investigate accommodation adherence and long-term concussion recovery.

Applications In Sports
Student-athletes receiving academic accommodations may return to play sooner, as academic accommodations allow them to recover from injuries at a quicker pace.

Keywords: Concussions; Return to Learn; RTL; Return to Play; RTP; Adolescent; Accommodations

INTRODUCTION

The heterogeneity of sports-related concussions (SRC) makes it a difficult injury to classify. While the physiologic understanding of brain injuries is increasing, this does not explain factors that place certain groups at greater risk than others for persistent post-concussive symptoms. High school aged students, with their on-going physical and cognitive development, are a particularly vulnerable population in part because of their continued development (1, 2). Additionally, there is a paucity of studies focused on this age group (1, 2). Clinically, this has created a challenging task for healthcare providers when establishing a prognostic time of recovery for adolescent SRC (2).

Public concern over adverse long-term concussive effects has led to an increase in research, educational programs, and youth sports-concussion management laws in all 50 states (3). Unfortunately, these changes have revolved mostly around safe return to physical activity (Return to Play/ RTP) and not enough around school reintegration (Return to Learn/ RTL) (4). Recommendations regarding school accommodations were not being actively discussed until 2009, and as explained by Thompson et al. (2016), only eight states have since passed

legislature addressing RTL protocols despite heightened concussion awareness. Even then, the enforcement of legislation is an ongoing concern (4, 5). Only three states (IL, MD, and NY) address the general student population in their protocols, as opposed to the “student-athlete,” and most are vaguely worded, with no specific mechanism to assess efficacy or outcomes (4).

Schools nationwide recognize the need to expand concussion management measures from the field into the classroom (6, 7). Likewise, medical providers need practical strategies, alongside prepared school systems, that are equipped with the allocated resources to provide academic support to recovering students (8). Longitudinal studies have pointed to adolescence as an important period of neuronal change, highly influenced by environmental factors (2, 9-11). This might explain the protracted recovery of high school aged student-athletes (15 days) when compared to their collegiate (6 days) and primary school aged (11 days) counterparts (11-13). While most adolescent SRC resolve in under 4 weeks, additional cognitive overexertion during this period of neurometabolic imbalance protracts recovery (2, 6). This is why students with persistent symptoms may require a response to intervention protocol (RTI), a 504 plan, or an Individualized Education Plan (IEP) (6, 14).

Despite legal limitations, there are strong programs in states without RTL legislation (4). These include Colorado’s REAP, Pennsylvania’s BrainSTEPS, and Oregon’s CBIRT concussion management programs (15-17). These programs have been successful, in part, due to their unique funding collaborations with state departments (e.g. Education and Health or Human Services)—creating and implementing RTL practices and training opportunities for educators (4, 18). Each program employs a variety of strategies such as classroom concussion assessment forms, training resources for academic faculty, and concussion management teams to monitor and evaluate students recovering from post-concussive symptoms.

The 2017 Concussion in Sport Group (CISG) Berlin expert consensus statement also suggests a collaborative approach to treatment. This includes controlled cognitive stress, pharmacological treatment, and school accommodations. Accommodations become particularly important when considering reintegration to a school setting, which is replete with symptom aggravators ranging from environmental and physical, to cognitive and affective (12, 19, 20). The CISG acknowledges the need for cognitive and physical rest during the acute phase (24-48 hours) after an injury, but emphasizes the importance of gradually increasing cognitive and physical activity during the recovery phase—while staying below symptom-exacerbating thresholds (2). Since school stressors could exacerbate symptoms and delay recovery, early and appropriate identification of school accommodation needs should become an essential part of any clinical concussion treatment plan (Table 1).

Table 1. Common Concussion Symptoms Addressed by Accommodation Type

Environmental	Physical	Curriculum	Testing
Headache	Headache	Impaired Cognition	Slowed Processing Speed
Sleep Disturbances	Fatigue	Impaired Working Memory (verbal/visual)	Slowed Reaction Times
Fatigue	Balance Problems	Impaired Executive Function	
Emotional Lability	Dizziness	Impaired Oculomotor Visual Function	
Balance Problems	Phonophobia		
Dizziness	Photophobia		
Phonophobia	Numbness/ Tingling		
Photophobia	Nausea		
Convergence Insufficiency	Repeat Injury		
Accommodation Deficits			
Saccadic Dysfuction			

The CISG-recommended multifocal approach is currently being implemented by the University of Miami's UConcussion Program, where certified athletic trainers (AT) employed by the Miami-Dade County Public High School (MCD-PHS) system are trained annually to assist in the management of student-athlete concussions. The Countywide Concussion Care Protocol (CCCP) was developed and implemented in 2012 to expand upon the limited regulations required by state law (21). Step 4 in the 6 Steps-to-Safe-Play protocol (Figure 1) includes a clinical visit, in which a student is evaluated by a multi-disciplinary medical team and is educated about his or her injury. It is during this encounter that recommendations for RTP and RTL are provided. Given the need for evidence-based literature regarding RTL accommodations and current concussion management strategies specific to the adolescent student-athlete, the UConcussion Program is in a unique position to use this model to describe the current RTL protocol implemented throughout the county (2, 8, 19, 21, 22).

Figure 1. Countywide Concussion Care Protocol (CCCP)- 6 Steps to Safe Play

1. Pre-season Baseline	2. Sideline Testing	3. ImPACT Re-Test	**4. Clinic Follow-up**	5. Return To Play	6. Injury surveillance
Prior to play, a coach or AT administers each of the following tests to set a baseline for the athlete: 1. ImPACT: The Immediate Post Concussion Assessment and Cognitive Test is a 45-minute computer-based test. It measures memory and reaction times. The athlete's initial test becomes the comparison by which that athlete's future ImPACT tests are compared. 2. King-Devick: A 5-minute, tablet-based, sideline screening test that measures eye movement and neurological functions. Like ImPACT, the initial King-Devick test is used for comparison when the athlete is retested following a possible concussion. These tests are administered pre- season for athletes that play contact sports who are 13 years of age or older.	When an athlete shows signs or symptoms of a concussion, they must immediately be removed from play and evaluated by a certified athletic trainer (AT) with SCAT3 and/or King-Devick tests. These sideline tests assist in determining if the player has actually received a concussion and thus should be removed from play.	Within 24 to 72 hours following the injury, ATs are advised to re-test the concussed player with ImPACT once again. Miami-Dade County Public School ATs - who work directly with our concussion program - then send the ImPACT test scores to our program for evaluation, and advise the player's parents to make an appointment with our concussion clinic.	**As soon as possible, parents of a concussed athlete should make an appointment for their child or teen athlete to visit our concussion clinic for the following tests, evaluations, and recommendations:** • **Neurological evaluation & concussion education** • **Vestibular evaluation** • **Neuropsychological assessment** • **Review of ImPACT scores by a Credentialed ImPACT Consultant (CIC)** • **Recommendations for return to play (GRTP, RTP) and return to learn (school accommodations)**	Once the athlete is completely free of symptoms and has been evaluated and examined by a physician to be asymptomatic, said physician will clear the player to begin the Gradual Return to Play (GRTP) protocol. If the player remains symptom free following GRTP, they may return to full contact play once medically cleared (in writing) by a physician.	Once the athlete has returned to full-contact activities, the athletic trainer will submit a concussion injury report through our site. Please note this form is for Miami-Dade County schools' ATs only.

The purpose of this study was to describe a symptom-based distribution of Return to Learn school academic accommodations for adolescent student-athletes recovering from sports-related concussions that can be facilitated as part of their clinical care, while exploring

differences between student-athletes who received accommodations and those who did not.

METHODS

Subjects

From January 2014 to January 2017, 308 student-athletes aged 13 to 19 years from the 35 MDC-PHS presented for clinical care at the UConcussion Program. All subjects were enrolled in the clinical data registry. Those excluded were from private and charter schools, other counties, and children aged 12 and under. Only SRC's were included in data analysis. Approval for this study was obtained from the Miami-Dade County Public School Department of Athletics and the University of Miami Institutional Review Board.

Protocol and Outcome Measures

The MDC school board mandates that every public high school employ an AT to treat student-athletes in case of injury. The UConcussion Program facilitates an annual training workshop to educate and train AT and their Athletic Directors on current concussion management protocols. AT receive training on ImPACT (ImPACT Applications, Inc., San Diego, CA) testing in order to administer baseline tests to student-athletes every two years as well as post-injury tests following a concussion (23). They are also trained on SCAT3 (Sports Concussion Assessment Tool 3, Zurich, Switzerland) and King-Devick (King-Devick technologies, Inc., Oakbrook Terrace, IL) sideline testing to screen for possible concussions on the field (24, 25).

Student-athletes exhibiting concussion symptoms are immediately removed from play by their AT and undergo the CCCP 6 Steps-to-Safe-Play protocol (21). The protocol requires that student-athletes undergo pre-season baseline and post-injury sideline testing to determine removal from play. Within 24-72 hours of injury, the AT administers a post-injury ImPACT test and contacts the UConcussion program director to review scores and schedule a clinical appointment for medical evaluation and treatment. A clinical visit is set up as soon as possible post-injury. During their first clinical visit, patients are seen by the program director, a neurologist, and, if needed, a neuropsychologist and/or neurotologist. The neurologist preforms a complete neurologic evaluation and reviews the patient's history, symptom complaints, and ImPACT clinical report. Following the completion of the evaluation, if the patient is determined to have neurocognitive issues associated with a concussion, academic accommodations are recommended.

The AT, as well as research coordinators, enter relevant patient and clinical information into the Research Electronic Data Capture (REDCap) management system (26). If school accommodations are recommended (Appendix), the amount, frequency, and specific type of accommodation is entered into REDCap for each clinical visit. Once the medical team decides that the patient is ready to return to contact sports, a Gradual Return to Play (GRTP) protocol is issued, in which the patient begins with low intensity exercise and builds up to full contact play, typically within three days. The school AT, in conjunction with school principal and athletic director, monitors all recommendations. If the patient is not cleared to begin the GRTP

protocol, weekly follow-up clinical visits are scheduled to continuously monitor the concussion management plan until the student-athlete is either cleared for contact sports or otherwise chooses to no longer follow-up.

Data Analysis

A single-center, cross-sectional retrospective analysis was conducted of patients who presented to the UConcussion Program. Patient recovery data and physical examination data was extracted from REDCap for further analysis. Baseline and post-injury ImPACT scores were reviewed and compared for student-athletes receiving school accommodations (SA) and a comparison group of student-athletes not receiving school accommodations (NSA). Descriptive statistics including mean, standard deviations, and frequencies were used to characterize the total sample and compare SA and NSA groups in terms of demographic characteristics and injury-related factors (Table 2). Independent sample t-tests were completed to evaluate any differences between age, days withheld, and days between injury and first clinical visit. Pearson Chi Square tests of independence were completed to examine differences between gender, injury year, history of previous concussions, loss of consciousness (LOC), and type of sport played. ImPACT baseline and difference scores between SA and NSA groups were compared using an independent sample t-test. Differences between ImPACT baseline and post-injury scores within SA and NSA groups were examined using a paired-sample t-test. Statistical significance was set at p ⫤ 0.05. These analyses were conducted using SPSS version 22.0 (IBM SPSS Statistics, IBM Corporation, Armonk, NY) (27).

Table 2. Comparison of Cohort Demographic and Concussion-Related Variables

Characteristic		ACCOMMODATION N=72	NO ACCOMMODATION N=236	P- Value
Age, years		16.03 (1.15)	16.02 (1.16)	0.966
Sports- Related Concussion		72 (94.7)	236 (97.9)	0.144
Date of Injury				0.278
	2014	26 (36.1)	63 (26.7)	
	2015	24 (33.3)	84 (35.6)	
	2016	22 (34.7)	89 (37.7)	
Gender				0.001
	Male	47 (65.3)	196 (83.1)	
	Female	25 (34.7)	40 (16.9)	
Sport				0.007
	Football	35 (48.6)	163 (69.1)	
	Soccer	17 (23.6)	30 (12.7)	
	Basketball	8 (11.1)	18 (7.6)	
	Other Sports	12 (15.8)	25 (10.4)	
History				
	Loss of Consciousness	7 (9.7)	27 (11.4)	0.405
	Reported Previous Concussion	14 (19.4)	22 (9.3)	0.046
Days Between Injury and Clinic		12.97[a] (12.97)	14.45[a] (26.71)	0.650
Days Withheld (Return to Play)		39.11[b] (35.59)	21.39[b] (28.82)	<0.005

Values are expressed as mean (SD) or N (%)

[a]2 student-athletes presented in clinic >90 days post-injury: 1 in accommodation (n=72) group; 1 in no accommodation (n=236) group

[b]10 student-athletes were not cleared: 8 in accommodation (n=72) group; 2 in no accommodation (n=236) group

RESULTS

A total of 308 MDC-PHS student-athletes were seen at the UConcussion clinic. Of these, 72 received school accommodations while 236 did not. The mean age within both groups was 16 years old (range, 13 to 19 years). The mean time between date of injury (DOI) and first clinical visit was 14.11 days (range, 1 to 85 days) and the mean recovery time (noted by a clearance for RTP) was 25.2 days (range, 3 to 186 days). Only two subjects were seen in clinic > 90 days post-injury and were excluded. Half of all patients seen at clinic (54.2%) were evaluated within the first 10 days post-injury and 98.6% (71 of 72) of student-athletes who received accommodations, did so during their first clinical visit (Table 3).

Table 3. "Return to Learn" Accommodations Provided in Clinic: 2014-2017

Type of accommodation	Visit 1	Visit 2	Visit 3	Visit 4	Visit 5
Accommodations given per visit	71/317 (22.4%)	30/122 (24.6%)	15/52 (28.8%)	7/24 (29.0%)	3/6 (50.0%)
Environmental	**27.7%**	**27.0%**	**23.4%**	**14.3%**	**16.7%**
No attendance	9 (12.7%)	3 (10.0%)	0 (0%)	0 (0%)	0 (0%)
Modified attendance	6 (8.5%)	4 (13.0%)	3 (20.0%)	0 (0%)	0 (0%)
Frequent rest breaks when requested (quiet room/ nurse's office)	30 (42.2%)	12 (40.0%)	4 (26.7%)	3 (43.0%)	1 (33.3%)
Limited screen-time use of computer, television and text messages	34 (47.9%)	13 (43.0%)	7 (46.7%)	1 (14.3%)	1 (33.3%)
Physical	**56.0%**	**46.7%**	**46.7%**	**35.8%**	**16.7%**
No physical education class	40 (56%)	14 (46.7%)	7 (46.7%)	2 (28.6%)	0 (0%)
No contact play or practice	40 (56%)	14 (46.7%)	7 (46.7%)	3 (43.0%)	1 (33.3%)
Curriculum	**44.1%**	**48.7%**	**37.8%**	**33.4%**	**33.3%**
Extra time to complete assignments/homework	32 (45%)	16 (53.0%)	6 (40.0%)	3 (43.0%)	1 (33.3%)
Reduced workload when possible	32 (45%)	15 (50.0%)	6 (40.0%)	2 (28.6%)	1 (33.3%)
Pre-printed or assistance with class notes	30 (42.3%)	13 (43.0%)	5 (33.3%)	2 (28.6%)	1 (33.3%)
Testing	**25.4%**	**28.3%**	**36.7%**	**28.7%**	**33.3%**
No test/quizzes	19 (26.8%)	10 (33.3%)	6 (40.0%)	1 (14.3%)	1 (33.3%)
Additional time on tests	17 (23.9%)	7 (23.3%)	5 (33.3%)	3 (43%)	1 (33.3%)
Other	**8 (11.3%)**	**7 (23.3%)**	**1 (6.7%)**	**2 (28.6%)**	**0 (0%)**

Data are percentages (frequency provided/ decreasing amount of returning patients)

Of those patients seen in clinic, 87.9% of accommodations were given to student-athletes in three sports: football (64.3.1%), soccer (15.3%), and basketball (8.4%). There was no difference between the SA and NSA groups with regards to age ($p = 0.966$), injury year ($p = 0.278$), LOC ($p = 0.905$), days between injury and first clinical visit ($p = 0.650$), or baseline ImPACT scores ($p = 0.400$) (Table 4).

Table 4. Comparison of ImPACT Baseline and Post-Injury Composite Scores of SA (n=50) and NSA (n=189) groups			
Variable	**ACCOMMODATION**	**NO ACCOMMODATION**	**P- Value Between Groups**
Total Symptom Score			
Baseline	3.02 ± 6.99	4.00 ± 7.41	0.400
Post-Injury	21.64 ± 17.64[b]	7.45 ± 11.30	<0.005
Difference Between Baseline and Post-Injury	18.62 ± 19.57	3.45 ± 12.96	<0.005
Verbal Memory[a]			
Baseline	45.66 ± 27.79	46.50 ± 30.10	0.858
Post-Injury	33.09 ± 30.20[b]	45.39 ± 29.81	0.010
Difference Between Baseline and Post-Injury	-12.57 ±39.20	-1.11 ± 36.29	0.052
Visual Memory[a]			
Baseline	49.66 ± 26.70	45.87 ± 30.21	0.421
Post-Injury	31.10 ± 24.62[b]	42.11 ± 31.24	0.009
Difference Between Baseline and Post-Injury	-18.56 ± 35.81	-3.76 ± 32.62	0.006
Motor Processing Speed[a]			
Baseline	42.47 ± 32.49	33.15 ± 29.11	0.129
Post-Injury	28.45 ± 28.86[b]	35.56 ± 29.49	0.051
Difference Between Baseline and Post-Injury	-14.03 ± 31.47	-2.41 ± 22.23	0.001
Reaction time[a]			
Baseline	45.50 ± 29.21	34.89 ± 25.58	0.301
Post-Injury	30.40 ± 25.80[b]	34.62 ± 25.61	0.012
Difference Between Baseline and Post-Injury	-15.10 ± 31.68	-0.26 ± 25.12	0.001
Impulse Control (test validity)			
Baseline	6.72 ± 5.08	7.06 ± 6.00	0.715
Post-Injury	8.70 ± 8.91	6.58 ± 5.86	0.116
Difference Between Baseline and Post-Injury	1.98 ± 9.13	-0.48 ± 6.75	0.035

[a]Percentile Ranking of Composite Score.
[b]P- value significantly different from Baseline Score $P \leq 0.05$.

However, there were differences with regards to gender ($p = 0.001$), days withheld from contact sport (recovery time, RTP) ($p < 0.005$), reported previous concussion ($p = 0.046$) and post-injury ImPACT scores ($p < 0.005$) (Table 4). More males (78.9%) were seen at the clinic as compared to females (21.1%), however a higher percentage of females (38.4%) were given accommodations as compared to males (19.3%). Finally, even though there was no difference in the time between DOI and first clinical visit among the two groups ($p = 0.650$), patients given accommodations had a significantly longer recovery time (RTP = 39.11 days) compared those not given accommodations (RTP = 21.39 days).

Comparison of Recovery Time

Recovery time data was determined for 96.8% of patients (298 of 308). Ten student-athletes were never cleared for contact sports (RTP) and either never returned to the clinic, or left the sport but continued their medical care at the clinic on an on-going basis. Two were excluded because their initial clinical visit was greater than 90 days post-injury. Independent sample t-tests revealed that student-athletes receiving accommodations experienced a significantly longer recovery time than those not receiving accommodations ($p < 0.005$). The mean number of days from DOI to medical clearance (RTP) was 39.11 ⥱ 35.59 days (range, 3 to 186 days) for student-athletes receiving accommodations compared with 21.39 ⥱ 28,92 days (range, 3 to 148 days) for student-athletes not receiving accommodations.

Comparison of ImPACT and Symptom Scores Between SA and NSA Groups

There were 239 student-athletes, comprising 50 in the SA group and 189 in the NSA group that had both ImPACT baseline and post-injury test scores. The comparison group was

included to provide insight into post-injury symptom severity and its correlation to protracted recovery and school accommodation needs.

Normative percentile rankings of ImPACT composite scores were used, when available, to compare SA and NSA baseline and post-injury performances both within and between groups (Table 4). There were no significant differences between the SA and NSA groups on any baseline composite scores. Likewise, there were no significant differences in pre- and post-injury impulse control scores, which served as a test-validity measure, within either group. There were no significant differences in pre- and post-injury scores within the NSA group. However, there were significant differences between all pre- and post-injury scores within the SA group: symptom score ($p < 0.005$), verbal memory ($p = 0.028$), visual memory ($p = 0.001$), motor processing speed ($p = 0.003$), and reaction time ($p = 0.001$). Of note, post-injury ImPACT symptom scores were significantly higher for the SA group as compared to the NSA group ($p < 0.005$) despite having similar baseline scores ($p = 0.400$). Symptom scores score the total number of symptoms a student-athlete reports. Furthermore, there were significant differences in the changes of pre- and post-injury scores between the two groups in visual memory ($p = 0.006$), processing speed ($p = 0.001$) and reaction time ($p = 0.001$).

Comparison of Clinical Visits Between SA and NSA Groups

During their first clinical visit, 71 student-athletes received school accommodations. From these, 64.8% (46 of 71 students) were cleared by their second visit one week later. The number of student-athletes given accommodations continued to decrease by half for each subsequent weekly follow-up visit. This is comparable to students not given accommodations. Of these, 61 student-athletes were not given school accommodations during their first clinical visit but were not immediately cleared for RTP. From these, 73.8% (45 of 61 student-athletes) were cleared by their second visit.

DISCUSSION

In order to implement effective RTL protocols, it is first necessary to better understand the symptoms and risk factors associated with protracted recovery to quickly identify high-risk student-athletes more likely to struggle in school, early on (11, 22). The SA and NSA student-athlete groups give insight into quantitative factors that may influence qualitative outcomes, such as difficulties in school following a concussion—represented by symptomatology and recommended school accommodations (Table 1).

While a matrix is not currently used to distribute accommodations, the general pattern has been to begin by addressing physical complaints first, followed by curriculum and testing accommodations in subsequent visits (Table 3). After the fourth visit, the distribution of accommodations is more widespread, reflecting the specific needs for different student-athletes. Environmental accommodations such as “frequent breaks” and “limited screen-time use” are common throughout, as they support the gradual return to learn recommendations of lowering stressors that can worsen concussion symptoms and delay recovery (10, 12, 19, 22, 30). This approach allows student-athletes to challenge themselves cognitively, without risking overstimulation and symptom exacerbation.

Being that the general recommendation for concussion recovery is to improve sleep and reduce stress, it follows that the most common accommodations were rest breaks, limited screen-time, limited physical exertion, and extra time to complete assignments/homework. Currently, student-athletes and parents may not understand the importance of receiving school accommodations post-injury, and may advocate against receiving these accommodations if symptoms are mild. Student-athletes may decline accommodations or downplay their symptoms in front of parents and physicians so that they can get back in the game more quickly. However, as indicated throughout the literature as well as within the UConcussion clinic, limiting cognitive overexertion can actually help expedite concussion recovery. While the effectiveness of this procedure cannot be quantified without a controlled study, it does follow that of the five student-athletes who did not receive accommodations from their first visit, but did so during a subsequent visit, one never returned to contact sports and the remaining four had longer recovery times (57.50 days) than those receiving accommodations from their first visit (37.88 days).

The Berlin expert consensus is that persistent symptoms should reflect a failure of normal clinical recovery: this includes symptoms that persist longer than 10-14 days for adults, and longer than 4 weeks for children and adolescents under 18 years old (2). At the UConcussion Clinic, the average recovery time of student-athletes in the NSA group was under 4 weeks. However, 55.3% (42 of 76) of student-athletes in the SA group took longer than 4 weeks to recover, 12 of which were never cleared, indicating a protracted recovery for student-athletes receiving accommodations. This supports the Berlin consensus statement that the strongest and most consistent predictor of slower recovery from SRC is the severity of a person's initial symptoms after injury (2). That, along with evidence showing the high-school years as the most vulnerable time period for persistent symptoms, particularly among girls, brings attention to the need of evidence-based research for this age group (2, 8, 19, 22).

This was a highly homogenous group where a major risk-factor for longer recovery—age—was removed. Yet despite similar demographic characteristics and neurocognitive baseline scores, one group had a significantly longer recovery time. Contrary to what may be expected, there was no difference between the SA and NSA groups with regards to the amount of days between injury and first clinical visit, nor LOC. However, differences in accommodation distribution, recovery time, post-injury symptom scores, and post-injury ImPACT performance were observed among female student-athletes, suggesting gender may be an indicator for protracted recovery. As has been noted in the literature, adolescent female patients may warrant higher monitoring following a concussion due to various causes including hormonal effects on inflammatory reactions, which may increase tissue damage in response to head trauma (9, 28). Social role norms and gender differences in safety attitude and risk behavior resulting in the underreporting of post-concussive symptoms among males may also be a key factor (29). This was evident in higher baseline symptom scores for males as compared to females, and greater performance by females across several measures. However, despite the higher scores, there were larger differences between ImPACT baseline and post-injury performance for females as compared to males.

Limitations

There are some limitations to this study. The sample size reflects the high volume of student-athletes seen at clinic and may thus not be generalizable to other non-sports adolescent injuries. About 23% of participants were lost to follow-up, which may have affected certain aspects of the results, including days between injury and clearance. Amnesia is mentioned as a potential indicator for protracted recovery throughout the literature; however, this data is not being properly captured at the clinic. The ImPACT test has limitations, given that patients are self-reporting their symptoms, such that they may not report symptoms in order to return to play sooner. Similarly, there is an inherent limitation to using computerized testing, which has a high visual demand, following a head injury.

Future studies designed to monitor accommodation changes, accommodation adherence, and their academic benefits would further this field of research (7). One major limitation of the UConcussion model is that AT serve as the main intermediaries between the prescribing clinician and school system. Schools and counties without AT looking to adopt this model would have to rely on an identified nurse or school counselor as a substitute facilitator. Additionally, school principal and athletic director need to work together with teachers to enforce school accommodations for the duration of time it takes the student-athlete to recover. This study does not report how strict enforcement of these accommodations were done by school staff.

Conclusion

Return to Learn is an important part of concussion management protocols. Teachers and school administrators need to recognize that post-concussion student-athletes may not be aware of the severity of their injury or may be actively trying to hide symptoms. The treating clinicians and family members need to remember that post-concussion symptoms can include behavioral changes along with cognitive and physical deficits. Student-athletes need to be made aware that even though there are several factors regarding concussions beyond their control, they do have direct control over their sleep and stress levels which can dramatically improve recovery time. Interventions like school accommodations can help fill the gaps while the brain recovers, but concussion management is ultimately a team effort with each member serving a vital role.

Standardized protocols on how to deliver school accommodations have yet to be disseminated. But with youth concussion legislation passed in every state for RTP, the next step is to provide school systems with similar tools for RTL. Concussion programs across the nation have created collaborations between medical, school, and state departments in order to centralize research, treatment, and funding. This centralization has allowed these programs to expand, even without RTL legislation. The knowledge gained from this study will help inform others in the community about an effective alternative approach to provide school accommodations to their student-athletes in a busy clinic—using key county stakeholders to uniformly implement post-concussive recommendations following SRC. By maximizing the

strengths and resources unique to their area, other counties and states can create comprehensive concussion programs that will improve accessibility to safe concussion management for all student-athletes.

APPLICATIONS IN SPORT

The inclusion of academic accommodations for student-athletes who receive concussions may help these individuals recover faster from their injury. Medical professionals, athletic trainers, and school staff should collaborate to provide the appropriate academic accommodations and work with student-athletes to use them in and out of the classroom.

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APPENDIX

RETURN TO SCHOOL FORM / ACCOMMODATIONS