



RESEARCH ARTICLE

Medical Management of Males and Females in Return to Learn and Return to Play after Concussion: An Observational Study

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Abstract

This study aimed to 1) Describe differences in medical management between males and females after a concussion, and 2) Explore factors associated with the number of days to Return to Learn (RTL) and Return to Play (RTP). 111 subjects, aged 12-19 with sports-related concussion participated. Independent samples t-tests, chi-square tests, and Poisson regression were used to determine the predictors for the days to RTL and RTP. Females received recommendations for school and sports restrictions more often than males ($p < 0.03$), were held out of sports twice as long as males ($p = 0.002$), and did not have full RTL 3 times longer than males ($p < 0.001$). Post-Concussion Symptom Score at baseline was the only significant predictor of the number of days to RTL ($p < 0.001$) and sex was the only significant predictor of the number of days to RTP ($p = 0.04$). The results of this study demonstrate specific medical management differences between the sexes after concussion. Understanding these differences may aid in the development of sex specific guidelines for RTL/RTP.

Keywords

Sports-related concussion, Adolescent athlete, Return to learn, Return to play, Academic accommodations, School restrictions

Main Body

Medical management of males and females in return to learn and return to play after concussion: An observational study.

Introduction

Although an estimated 1.1-1.9 million sports- and

recreation-related concussions occur annually amongst United States youth ages 18 and under [1], limited evidence is available to guide medical management. This topic is of growing concern as there has been an overall 60% increase in the incidence of reported concussion between 2007 and 2014, with the largest increases occurring in the 10-14 year-old (143%) and 15-19 year-old (87%) age ranges [2]. Additional data examining emergency department visits for concussion between 2001 and 2005 amongst United States youth aged 8 to 19 found that approximately half of all visits for concussion were sports-related [3]. Since evidence suggests the youth population takes longer to recover from concussion than college athletes [4-7], clinical guidance is needed to address the aftercare of these types of injuries.

The management of concussion for adolescents as athletes has been described and is routinely recognized through the establishment of "Return to Play" (RTP) guidelines [8], however, limited attention has been given to the management of adolescents as students returning to the school environment, or "Return to Learn" (RTL) [9,10]. Specifically, research addressing the resumption of typical school participation in relation to the resumption of participation in sports remains lacking. Evidence has suggested that up to 43.5% of concussion cases return to play prematurely and 44.7% of concussion cases return to learn prematurely as demonstrated by a recurrence or worsening of symptoms with the return process [11]. Identifying the optimal time to

return a student-athlete to the learning environment is a delicate balance. On one hand, there is a need to prevent the worsening of concussion symptoms by over stimulating a concussed brain [12,13] and on the other, time out of school may increase the potential production of anxiety from missing school [10,14].

Recently, a protocol for RTL was developed through a scoping literature review and synthesis of stakeholder opinions [15]. This protocol endeavored to mirror the basic steps of the five stage RTP guidelines, with progression from full rest to full days of school. At this time, the implementation of this protocol, evidence of its effectiveness, or an evaluation of the timeframe for RTL has not yet been published. Additionally, there are no clear guidelines regarding what cognitive rest entails for students and how long it should last [11]. Similar to RTP, the research does suggest that RTL needs to be individualized and progressed by symptom resolution [15,16]. The following signs and symptoms may be associated with a lengthier recovery: history of prior concussion; greater number of concussions, severity or duration of symptoms post-concussion; female sex; a history of a learning disorder; attention deficit disorders; or mood disorders [9,17], and may impact the timeframe for RTL.

As guidelines develop to aid health care practitioners, school administrators, and parents in making decisions related to the learning environment, a better understanding of how the medical management of RTL relates to the established protocol for RTP is needed, particularly in examining differences in RTL between male and female athletes following a concussion. Any differences in recovery patterns between the sexes would provide valuable information regarding the approach for RTL and RTP; thus enabling the development of evidence based clinical guidelines, tailored to any unique features between males and females. The purpose of this study was to 1) Describe differences between males and females in medical management and timeline for RTL and RTP and 2) Explore the demographic, premorbid, and clinical factors associated with the number of days to RTL and RTP.

Methods

Study design

This is a secondary analysis of data collected as a part of a prospective observational study utilizing participants seen as patients at Akron Children's Hospital (ACH) Sports Medicine Center in Akron, Ohio. Two previous publications have utilized data from this cohort of participants [18,19]. The Institutional Review Board at Akron Children's Hospital and the Human Subjects Review Board at Walsh University approved the original research. Informed consent was granted by the parent or legal guardian of each participant or was obtained by the participant if he/she was 18 or older. Assent was obtained from those participants under the age of 18.

Setting

Participants were invited to enroll in this study if they presented to the ACH Sports Medicine Center between August 2013 and April 2014. Participants were followed from the first medical visit for management after a sports-related concussion through discharge from medical care. Data was collected through a structured patient interview conducted at the sports medicine center and from medical records related to the sports medicine visits. The data collected included documented concussion management strategies and prescribed activity restrictions.

Participants

A convenience sample was utilized for this study, which consisted of adolescent athletes ages 12-19 with a diagnosis of sports-related concussion. Participants were considered for inclusion in the sample if they sustained a concussion while participating in a sports activity. Participants were not considered for inclusion if concussion was sustained through a motor vehicle accident or other etiology unrelated to sports activity (recreational or organized). Participants included adolescents with a history of concussion, as well as those with no history of concussion.

Variables and data measurement

The data collected for each participant included: date of birth, sex, date of current concussion, date of initial assessment at the sports medicine center, and sport in which concussion occurred. Each participant and/or parent reported on the intake history and physical form, as per standard clinic practice, in answer to this question: "Have you ever had medical treatment for any of the following: headaches/migraines, and psychiatric condition (depression, anxiety)?" Participants were also asked to indicate if they had ever had a previous concussion or Attention Deficit Hyperactivity Disorder (ADHD/ADD). The total Post-Concussion Symptom Scale (PCSS) was recorded at the initial visit.

The PCSS is a 22-item self-report symptom scale routinely utilized to track concussion severity and resolution of symptoms throughout recovery. The participant, on a 7-point Likert scale, ranks each of the 22 items from 0 (not a symptom the participant is experiencing) to 6 (severe symptom the participant is experiencing). The symptoms presented on the PCSS represent constructs including physical complaints (e.g. headache, dizziness, vision problems); emotional symptoms (e.g. sadness, irritability); sleep disturbances (e.g. sleeping more than usual, trouble falling asleep); and cognitive complaints (e.g. mentally foggy, difficulty remembering) [20,21].

Data was also collected regarding any prescribed recommendations for physical and mental rest, restrictions from school, accommodations within school, and restrictions from physical activity. Physician recommen-

dations of “no school” or “half day in school”, were categorized as school restrictions. If any recommendations were made regarding an alteration in student participation while at school, the participant was regarded as requiring academic accommodations. Examples of academic accommodations included any of the following: receiving extra time to complete assignments, extra time for taking tests, reduced academic workload, or modified assignments. Physician recommendations of “no sports or physical education class”, or “able to begin low intensity physical activity (only)”, were categorized as sports restrictions. Each of these variables was collected at the initial medical appointment and at each follow-up appointment through discharge.

The operational definition for RTL was developed to mirror the well-established final stage for RTP [8]. For the purposes of this study, RTL was defined as full ac-

ademic participation with no restriction of school attendance and no academic accommodations. RTP was defined as full sports participation with no restrictions (Stage 5 of a RTP progression according to the Zurich guidelines) [8]. The number of days of treatment prior to RTP and RTL were defined as the time from the initial medical appointment to either return to play or return to learn.

Statistical analyses

Statistical analyses were completed with Statistical Analysis Software (SAS) 9.4. Descriptive statistics for the sample were calculated. Independent samples t-tests and chi-square tests were utilized to determine if there were differences between males and females in participant characteristics, past medical history, PCSS scores at the initial sports medicine visit, variables measuring medical recommendations provided for academic and

Table 1: Descriptive statistics for the sample.

	Males (n = 76)	Females (n = 35)	p-value	t-value	Effect size (d or OR)
Participant characteristics					
Age	15.0 (1.5)	15.1 (1.7)	0.73	-0.34	0.07
Sport			< 0.01		NC
Football	48 (64.9%)	1 (2.9%)			
Soccer	6 (8.1%)	9 (25.7%)			
Basketball	7 (9.5%)	10 (28.6%)			
Wrestling	3 (4.1%)	1 (2.9%)			
Swimming	1 (1.4%)	1 (2.9%)			
Rugby	1 (1.4%)	0			
Hockey	1 (1.4%)	0			
Cheerleading	0	3 (8.6%)			
Volleyball	0	2 (5.7%)			
Baseball/Softball	0	1 (2.9%)			
Lacrosse	0	1 (2.9%)			
Other	7 (9.5%)	6 (17.1%)			
Participant medical history					
History of previous concussion (yes)	22 (29.0%)	14 (40%)	0.25		1.64
History of headaches (yes)	15 (19.7%)	12 (34.3%)	0.10		2.12
Psychiatric condition (yes)	1 (1.3%)	7 (20.0%)	< 0.01		18.75
History of ADHD (yes)	10 (13.2%)	3 (8.6%)	0.49		0.62
Clinical characteristics					
Number of days between concussion and assessment	8.6 (6.3)	9.8 (15.1)	0.65	-0.46	0.09
PCSS score at initial visit	15.4 (16.1)	34.7 (25.4)	< 0.01	-3.06	0.63
Medical recommendations provided					
Academic accommodations (yes)	44 (57.9%)	31 (88.6%)	0.01		5.28
School restrictions (yes)	42 (55.3%)	29 (82.9%)	0.03		3.68
No school/work	23 (30.7%)	22 (66.7%)			
Shortened day	18 (24.0%)	6 (18.2%)			
Sports restrictions (yes)	61 (80.3%)	35 (100%)	< 0.001		17.89
No sports/physical education	52 (68.4%)	32 (91.4%)			
Low intensity physical activity only	9 (11.8%)	2 (5.7%)			
Number of days of treatment until:					
Return to play	18.0	44.3	0.002	-3.35	0.68
Return to learn	8.0	23.9	< 0.001	-4.48	0.92

Attention Deficit Hyperactivity Disorder = ADHD; Post Concussion Scale = PCSS; Psychiatric condition included anxiety disorder; depression; and bipolar disorder; History of headaches includes history of migraines; T-tests completed on continuous variables, Chi-Square analyses completed on categorical/binomial variables. Significant differences are based on alpha < 0.05; point estimate of effect sizes for differences between males and females calculated as *d* for continuous variables based on the t-statistic and Odds Ratios for dichotomous variables with males as the referent.

sports restrictions, and the number of days of treatment prior to RTL and RTP. Additionally, effect sizes were calculated, including Cohen's *d* for continuous variables and odds ratios for dichotomous variables to express the size of the difference between males and females. Exploratory univariate Poisson regression was completed to determine relevant participant, past medical history, and clinical predictors on the number of days to RTL and RTP. Univariate associations with a *p*-value of 0.10 or less were added to each final multivariable Poisson model for RTL and separately for RTP. Multivariable Poisson regression was completed for RTL and RTP with all relevant predictors. Significant associations in the multivariable model were based on $\alpha < 0.05$.

Results

In total, 111 participants were enrolled into the study, 76 males and 35 females. The descriptive statistics for the sample can be found in [Table 1](#). Most of the concussions occurred during participation in football for males and in basketball or soccer for females. A total of 36 participants had a history of a previous concussion, 27 had a history of headaches or migraines, and 13 total had a diagnosis of ADHD. According to chi-square analysis, the prevalence of these premorbid conditions was not significantly different between males and females (*p*-values between 0.10 and 0.49). Eight of the participants had a history of a psychiatric condition with significantly more females reporting this than males ($p < 0.01$; OR = 18.75). Participants reported to sports medicine for medical management at a mean of nearly 9 days after sustaining the concussion. At the initial medical visit, females demonstrated a significantly higher Post-Concussion Symptom Score than males ($p < 0.01$; $d = 0.63$).

As a component of the medical management of concussion, females received recommendations for academic accommodations ($p < 0.01$; OR = 5.28), school restrictions (no school or a shortened day; $p = 0.03$; OR = 3.68) and sports restrictions (including no sports/physical education or allow only low intensity physical activity) significantly more often than males ($p = < 0.001$; OR = 17.89). In addition, on average, females were held out of full participation in sports more than twice as long as males ($p = 0.002$; $d = 0.68$) and did not have full return

to learn for a period almost 3 times longer than males ($p = < 0.001$; $d = 0.92$) ([Table 1](#)).

Considering the predictors of the number of days to RTL, after univariate analysis, sex, history of headaches, psychiatric condition, and PCSS score at the initial medical visit were included in the final regression model ([Table 2](#)). PCSS score at the initial medical visit was the only significant predictor of the number of days to RTL ($p < 0.001$). Considering the predictors of the number of days to RTP, after univariate analysis, sex, history of previous concussion, psychiatric condition, and PCSS score at the initial medical visit were included in the final regression model. Here, sex was the only significant predictor of the number of days to RTP ($p = 0.04$).

Discussion

Our results indicate that females were provided academic accommodations, school restrictions, and sports restrictions more frequently than their male counterparts prior to returning to full scholastic or athletic participation. In addition, females were held out of sports and school participation significantly longer than the males in this study. Similar to the findings of this current study, existing literature supports the notion of females faring worse when related to concussions. Females have a higher rate of concussions in high school sports played by both sexes [22,23]. Additionally, female high school and college athletes have more post-concussion symptoms and are 1.7 times more likely to be cognitively impaired after a concussion [24]. Overall, a recent meta-analysis reveals that traumatic brain outcomes are worse in females than males [25].

The differences in symptomatic presentation and timeline for recovery in males and females is neither fully understood nor consistently reported in the literature. One study on 10 to 18-year-olds found that although females experienced greater symptoms pre-concussion and in the acute post-concussive state, they experienced similar recovery times as compared to males [26]. In contrast, in a study on a sample of 18-23 year-olds, no significant difference was found between males and females in symptom presentation initially; however, male subjects were more likely than female subjects to be symptom free at 4 weeks [27]. In this present study,

Table 2: Predictors of number of days to Return to Learn (RTL) and Return to Play (RTP).

	Parameter estimate	SD (95% CI)	p-value
Number of days to Return-To-Learn			
Sex (female)	0.654	0.277 (0.110, 1.200)	0.06
History of headaches (yes)	0.001	0.218 (-0.426, 0.429)	0.99
Psychiatric condition (yes)	-0.029	0.315 (-0.646, 0.588)	0.93
PCSS score at initial visit	0.016	0.005 (0.007, 0.026)	< 0.001
Number of days to Return-To-Sport			
Sex (female)	0.894	0.297 (0.312, 1.476)	0.04
Previous history of concussion (yes)	0.427	0.2528 (-0.021, 0.874)	0.12
Psychiatric condition (yes)	0.085	0.252 (-0.409, 0.578)	0.74
PCSS score at initial visit	-0.002	0.006 (-0.013, 0.010)	0.77

Post Concussion Scale = PCSS; Multivariable Poisson regression models presented. Significant values based on $\alpha < 0.05$.

PCSS score at the initial medical visit was the only significant predictor of the number of days to RTL, with sex held constant. This potentially indicates that within our sample, RTL decisions are based on clinical factors separate from the patient's sex. In contrast, sex was the only significant predictor of the number of days RTP, with females taking significantly longer to return to play than males, with PCSS score held constant.

There are multiple potential reasons for the differences in outcome related to RTP between male and female athletes as described in this present study. From an anatomical and physiological perspective, the sexes have different intrinsic abilities to withstand blows to the head-neck complex. Research findings have demonstrated that females have greater head-neck angular acceleration and displacement than males even though they initiate muscle activity earlier and use a greater proportion of their total available muscle activity. These differences may be explained by less isometric strength, head mass and neck girth than their male counterparts [28-31]. On average, this difference in anatomy may result in more severe functional brain injuries in females than males. Thus, females would require a longer time to attain a level of overall recovery necessary for a medical professional to release the athlete for RTP.

Hormonal differences may also contribute to the differences seen with recovery. Beginning at baseline, females are 43% more likely than males to report symptoms [32]. Females may never become asymptomatic due to the role of the menstrual cycle as many of the symptoms females experience at baseline (headache, difficulty concentrating, emotional symptoms, and energy/sleep disturbances) are associated with the menstrual cycle [33,34]. Finally, there may be cultural influences that lead to greater reporting of concussion symptoms in female versus male athletes, with males avoiding or under-reporting symptoms [21,35,36]. Conversely, female athletes may have more concern for their future health and may be more forthcoming in their reporting [25]. Thusly, hormonal influence and behavioral reporting in females may intensify the expressed severity of the concussion. Because recovery is dependent upon patient report, these differences by sex could certainly influence when a medical provider is comfortable granting RTP and may explain, in part, reasons why females are held out from RTP longer than males. Further research on anatomical, hormonal and cultural influences on the difference in concussion recovery time between the sexes is warranted to explore and better understand these potential relationships. This knowledge may aid in the creation of sex specific guidelines for RTL and RTP. In the meantime, providers may need to look beyond symptoms to the potential cause of the symptoms (anatomical, hormonal, cultural), particularly in female patients, to aid in determination of appropriate RTL and RTP timelines.

Limitations

Although the data for the original research study were collected prospectively, the study was conducted at a medical clinic where a cohort of physicians and nurse practitioners made medical management decisions pragmatically and entered these decisions into a medical record. Although collected from one sports medicine center, there was no standardization of the decision-making processes between the providers, which creates the potential for differing decision-making drivers related to return to sport/school. Additionally, there were likely differences in documentation practices since the purpose of the documentation was medical, not research-oriented. Therefore, the results may not be easily generalizable to another medical clinic or cohort. Additionally, the outcomes associated with this sample are likely not representative of all student athletes who sustain a sports-related concussion because participants in this study were enrolled based on seeking medical management at a sports medicine center for their concussion symptoms. There may be important differences between parents and athletes who seek medical management and those who do not. Lastly, it should be noted that because there is a clear difference in the types of sports represented by males and females within this sample, it is possible that some of the differences that were found in this study are related to sport and not necessarily only sex. This was unable to be further explored.

Conclusion

As sports-related concussion remains a prevalent concern for adolescent athletes, standards for RTL must continue to be developed and monitored in a similar way to the guidelines and regulations in place for RTP. Our findings uncover differences in recovery trajectory from a concussion between males and females along with the factors influencing the timeframes for return to participation in school and sports. This research may help to inform the development of additional evidence-based guidelines for adolescents and children with sports-related concussion.

Conflicts of Interest and Source of Funding

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