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Healthcare professional involvement and RTP compliance in high school athletes with concussion

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Abstract

Objectives: To describe concussion rates in high school athletes and involvement of healthcare professionals in concussion diagnosis, management and compliance with return to play (RTP) guidelines.

Methods: Data were analysed from injury reports in the National High School Sports-Related Injury Surveillance System between 2009/2010 and 2012/2013 to identify student athletes with concussion and determine compliance with RTP guidelines. Compliance with RTP guidelines was examined using logistic regression, adjusting for sport and injury-related variables.

Results: There were 5611 concussions recorded during 15 712 475 athlete exposures (AEs), a rate of 3.6 concussions per 10 000 AEs. Rates were higher during competition and among girls compared to boys in gender equitable sports. Healthcare professionals were less likely to be present at the time of concussion for girls' sports, lower competition levels and practices. Compliance with RTP guidelines was higher for athletes with recurrent concussions, those sustained in collision sports, for athletes reporting more symptoms and when a physician made the RTP decision.

Conclusions: Presence of healthcare professionals and compliance with RTP guidelines varied by sport, gender, level of play and exposure type. High school athletes with concussion are best served by assessment teams with athletic trainers and physicians working together to manage concussions and contribute to RTP decisions.

Keywords

Traumatic brain injury; concussion; return to play; high school athletes; healthcare professional; concussion management; athletic trainer

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Introduction

Traumatic brain injury (TBI) resulted in 2.8 million emergency department (ED) visits, hospitalizations and deaths in 2013, creating substantial healthcare system burden (1). Most TBIs are mild, commonly called concussions (1). Approximately 3.42 million ED visits for sports and recreational related (SRR) TBI occurred from 2001 to 2012, with the overall age-adjusted rate of SRR-TBI ED visits more than doubling during this time period (2). The majority of SRR-TBIs (70%) occurred among the ≤19-year-age group (2). It is estimated that high school athletes experience 300 000 concussions per year in organized school-based sports, with a higher frequency in competition compared to practice (3,4).

Since 2009, concussion legislation addressing concerns about health risks for younger athletes was passed in all states. Common legislation elements include coach education, removing athletes from play and requiring healthcare professional approval for return to play (RTP). RTP laws differ in terms of medical clearance requirements, reporting concussion history, and the medical specialty/training required for healthcare professionals who can authorize RTP. For example, in Massachusetts healthcare professionals authorized to provide clearance are physicians, nurse practitioners, certified athletic trainer (AT) or neuropsychologists, but in Washington, the state law specifies a ‘licensed healthcare professional’ without clear specification of specialty (5). A study conducted by Yard and Comstock (2009) prior to enactment of RTP legislation reported that many high school athletes with concussions from 2005 to 2008 did not adhere to existing RTP guidelines, and variations in compliance differed by sport and gender (6).

Previous research on high school athletes has not examined patterns of healthcare professionals’ presence at the time of concussion injury or the relationship between healthcare coverage and RTP compliance or whether the availability of healthcare professionals guide RTP decisions. Even in high schools with full time ATs, coverage across sports varies, as the AT cannot be physically present at all concurrently scheduled sports’ practices and competitions. It is important to know if healthcare professionals’ presence at the time of concussion and/or involvement with subsequent injury management positively affects adherence to RTP guidelines (6,7). The purpose of this study was to examine concussion rates in high school athletes, to describe patterns of healthcare professionals’ presence at the time of concussion by sport, level of play and gender and to investigate the relationship between healthcare professionals’ involvement and RTP compliance. The public health implications are considerable as concussions that are not managed appropriately can result in athletes returning to play before symptom resolution, placing them at greater risk for another concussion, more serious health problem and longer term sequelae (8–10).

Methods

Data source

The National High School Sports-Related Injury Surveillance System (HS RIO) collects data from a national sample of US high schools. A National Athletic Trainers Association (NATA) affiliated certified AT reports data related to injury characteristics, the injury event and athletic exposures (6,11). HS RIO concurrently captures data from two study samples, a

randomly selected nationally representative sample of 100 schools each of whom report on 9 sports and a broader, large national convenience sample of over 200 high schools which each report on varying combinations of 22 sports. For this study, all concussion data captured by either study sample were evaluated (6,11,12).

Variable definitions

Athlete exposure (AE), defined as athlete participation in one practice or competition, athlete demographics and injury data, were reported weekly by ATs. Injuries were reportable if they: (1) occurred during organized practices, performances (cheerleading only) or competitions; (2) required medical attention by an AT or physician and (3) resulted in restriction of the athlete's participation for at least one day. ATs were able to view previously submitted information and update reports as needed. For this study, sports were classified as collision (i.e., football), contact (i.e., lacrosse) or limited contact (i.e., baseball) as suggested by the American Academy of Pediatrics (13). Concussion data from 2009/2010 to 2012/2013 ($n = 5611$) were examined in the analysis.

Healthcare professional presence at the time of injury was extracted from the report form question: 'Was a medical professional on site when the injury occurred?' which was a 'check all that apply' question with options including: AT, AT identified trained concussion specialist, physician or other medical personnel (i.e., nurse practitioner, EMT, etc.), no medical personnel present at the time of injury, or 'unknown'. A second question, 'Injury was assessed by', was also a 'check all that apply' question that had multiple options to indicate the healthcare professional who assessed the concussion. Responses to this question were categorized for analysis by researcher consensus. An additional question, 'Who made the decision to allow the athlete to return to play or to keep the athlete from returning to play?' was a 'check one best answer' question that had also had multiple options. In this study, AT reporters were classified as healthcare professionals.

For the purpose of this study, RTP compliance was based on guidelines from the 2012 International Consensus Statement on Concussion in Sport (7). These guidelines are consistent with RTP guidelines found in International Consensus Statements since 2001 that have been widely disseminated to stakeholders (11,12,14). The guidelines recommend no RTP the day of the concussive injury, no RTP until symptoms have resolved and a progressive, stepwise RTP strategy following symptom resolution (7). Compliance with RTP guidelines was based on the difference in time between two HS RIO categorical variables: symptom resolution time and RTP time. Although there is some disagreement among clinicians about the number of days until older/elite athletes may safely return to play, for this study of high school athletes' RTP must have occurred at least 7 days after symptom resolution, assuming no RTP on the same day as the injury. Compliance could not be definitively determined when symptom resolution and RTP time categories did not provide adequate specificity.

Statistical analyses

Statistical analyses were performed using SAS (Version 9.3; Cary, North Carolina). Concussion rates, reported per 10 000 AEs were calculated by dividing the total number of

concussions by the total number of AEs and stratified by sport and exposure type (competition or practice). Rate ratios (RR) were used for subgroup comparisons:

$$RR = (\#\ \text{of boys' soccer concussions during competition})/(\#\ \text{of boys' soccer competition AEs})\,/\,(\#\ \text{of boys' soccer concussions during practice})/(\#\ \text{of boys' soccer practice AEs})$$

Calculated RRs with 95% confidence intervals (CI) not including 1.0 were considered statistically significant. Chi-square tests determined if differences existed in the presence of healthcare professionals at the time of injury by sport, gender, exposure type (i.e., competition vs. practice) and level of play(i.e., varsity, JV, freshman).

This study explored differences in concussion outcome measures (symptom reporting and RTP time in days) relative to the healthcare professional assessing the concussion. Differences in the mean number of reported symptoms were tested using ANOVA, while differences in categorical variables were evaluated using chi-square tests.

A logistic regression model determined factors associated with RTP compliance. Bivariate analysis was performed running crosstabs to explore explanatory variables with RTP compliance. Variables significantly associated with RTP compliance during bivariate analysis were included in the logistic regression model. Within this model, forward and backward selections were examined, built with criteria $p < 0.05$ for entry or inclusion; both models found similar results.

Results

Concussion rates

Concussion rates varied across sports, type of event and gender (Table 1). Overall, 5611 concussions occurred during 15 712 475 AEs (3.6 per 10 000 AEs; Table 1). The highest concussion rate was among boys' football during competition (31.4) and practice (4.6). For girls, soccer had the highest competition rate (16.2); lacrosse and basketball had the highest practice rates (each 1.4). Within all boys' sports, concussion rates were higher during competition than practice, except boys' swimming/diving. In gender-comparable sports, concussion rates were higher among girls than boys.

Healthcare professionals' presence at the time of injury

Healthcare professional presence at the time of injury varied significantly by exposure type, gender and level of play (Table 2). Healthcare professional coverage for concussions experienced in competition most frequently consisted of AT only (50.4% of competition concussions), other healthcare professional only (29.3%), no healthcare professional (9.2%) or an AT and a physician combined (8.3%). Healthcare professional coverage for concussions experienced in practice most frequently consisted of AT only (79.8% of practice concussions), no healthcare professional (13.3%) or other healthcare professional (5.3%). Physicians were present more frequently for concussions sustained at competitions (9.7%) compared to practices (0.5%; $p < 0.01$).

The type of healthcare professional available at the time of concussion varied by athlete gender. For all sports combined, ATs only were more often present when boys (64.6%) rather than girls (53.1%) sustained concussions ($p < 0.01$). Healthcare professionals (other than ATs or physicians) were more often present when girls (28.5%) rather than boys(17.2%) sustained concussions ($p < 0.01$). No healthcare professional was present when 16.1% of girls and 8.4% of boys sustained concussions. Physicians were present for 1.1% of girls' and 8.4% of boys' concussions.

Presence of physicians differed by level of play (varsity 10.9%, junior varsity 1.7%; $p < 0.01$). No healthcare professional was present for 11.0% of freshmen and 12.8% of junior varsity athletes' concussions compared with 9.4% of varsity athletes' concussions (Table 2). Healthcare professional presence also differed by sport. In football, physicians were present for 12.5% of concussions and 4.8% had no healthcare professional present. In comparison, physicians were present for only 1.4% of concussions in girls' soccer while there was no healthcare professional present for 15.7% of concussions.

Table 3 compares healthcare professionals' categories present at the time of injury with those involved in concussion assessment, which could have occurred at the injury time and location or at a different setting post injury. Of the concussions, 61.3% ($N = 3327$), which occurred when only an AT was present at the time of injury, athletes were most frequently assessed by 'AT and general physician' (43.5%) followed by 'AT only' (29.4%). When both a physician and AT were present at the time of injury, athletes were most frequently assessed by 'AT and general physician' (40.6%) followed by 'AT and orthopaedic physician' (35.5%). When no healthcare professional was present at the time of concussion, 'AT and general physician' (37.4%) followed by general physician or other healthcare professional most frequently assessed athletes (20.3%).

Healthcare professional assessment and RTP compliance outcomes

Compliance outcomes varied by the healthcare professionals involved with concussion assessments (Table 4). When AT alone assessed the athlete with concussion, RTP decisions were made by physicians 12.0% of the time, and by ATs83.9% of the time. RTP decisions were rarely made by coaches (0.4%), parents (0.7%) or athletes (0.3%), regardless of what healthcare providers assessed the concussion.

Overall, 30.9% of athletes with concussion complied with RTP guidelines, 14.6% were noncompliant; and in the remaining 54.5% of concussions, compliance could not be definitively determined due to classification of the symptom resolution time variable and the RTP variable or the person responsible for the RTP decision was missing (Table 4). When compliance could not be determined, 33.5% had symptom resolution times between 3 days and 9 days, and RTP between 10 days and 21 days. The length of time these athletes were held from play suggests most were likely compliant with RTP guidelines (e.g., an athlete with symptoms resolving in 3 days would be compliant if RTP was 10 days and an athlete with symptoms resolving in 9 days would be compliant if RTP was 16 days). However, compared to athletes who were definitely compliant with RTP guidelines, athletes of unknown compliance reported more concussion symptoms (5.0 vs. 4.7, $p < 0.05$), and were more likely to have initial rather than recurrent concussions (93.5% vs. 86.3%, $p < 0.05$).

Given these differences and to ensure a conservative analysis, only concussions definitively identified as compliant or non-compliant with RTP guidelines were included in the logistic regression analysis ($n = 2537$).

Factors contributing to RTP compliance

The odds of RTP compliance varied by healthcare professional type, sport variables, academic year and injury-related variables (Table 5). Athletes managed by a healthcare team that included an AT and a physician (neurologist, orthopaedic physician or general physician) had higher odds of compliance compared with athletes managed by ATs only (OR range from 1.9 to 11.9, $p < .01$). Athletes who had experienced a prior concussion were more likely to be compliant compared with athletes sustaining their first concussion (Odds Ratio (OR) = 2.2, $p < 0.01$). Athletes reporting more symptoms were more likely to be compliant. Athletes also had higher compliance odds if physicians rather than ATs (OR = 1.3, $p = 0.02$) made the RTP decision. Athletes concussed more recently (2012–2013) had higher odds of being compliant than those concussed earlier (2009–2010) (OR = 2.0, $p < 0.01$). Freshman and sophomores had higher compliance odds than seniors (OR = 1.7 each, $p < 0.01$). Athletes playing collision sports had higher compliance odds than those playing limited contact sports (OR = 1.5, $p = 0.02$).

Discussion

This study provides an update on high school sports-related concussion rates, explores patterns of healthcare professionals' presence at the time of concussion, and, for the first time, investigates how healthcare providers' involvement with assessing the concussion may influence RTP decision-making, a complex process that relies on clinical input and clearance, experience with concussion, as well as athlete and parent opinions about returning to a sport. Results corroborate prior findings about increased concussion rates over time and variation by sport, gender and type of exposure (3,4,6,15,16). Likely explanations for increased rates include more reporting due to heightened awareness of the importance of sports-related concussions, rather than an actual increase in concussion incidence (2,15,16).

Importance of healthcare professionals

While RTP compliance has improved over time, compliance varied by healthcare provider type involved in concussion management. Athletes participating in girls' sports, practices and non-varsity team sports were less likely to have healthcare professionals present at the time of injury compared with boys' sports, competitions and varsity teams. Athletes were more likely to follow RTP guidelines when assessed by teams of both ATs and physicians, or when specialized physicians were involved in concussion assessment. Presence of a healthcare provider at the time of injury varied by gender, level of play and exposure type, grade level and sport, factors associated with RTP compliance.

These findings validate state-level concussion policies requiring healthcare professional clearance for athletes to RTP. ATs are most likely to be on the field at the time of injury and play an important role in athlete triage, in referral to appropriate physician care, and in the RTP process. However, these results support the importance of physician involvement in the

RTP process. The best RTP compliance occurred when ATs and physicians worked as a team, a practice that can optimize athlete health and safety in RTP in high school. Concussion training for all healthcare professionals involved in high school athletes' care and consideration of their involvement at high school athletic events is warranted.

Factors affecting RTP compliance

Athletes reporting more concussion symptoms were more likely to be compliant with RTP guidelines. Athletes treated by specialized physicians reported significantly more symptoms than those treated by ATs only or less specialized physicians. Increased symptom reporting may result in referral to specialized medical care due to longer recovery periods.

Athletes with a concussion history, who take longer to recover (8,10), were more likely to comply with RTP guidelines suggesting concussion experience informs RTP decisions. Healthcare providers' inquiry about concussion history during assessment is an important consideration.

Athletes with concussion participating in collision sports, such as football, compared to sports with less contact as part of the sport, were more likely to comply with RTP guidelines. Healthcare professionals were more frequently present at the time of injury for collision sports implying preconceived notions regarding 'high risk' collision sports may affect opinions about concussion management and compliance. For example, providing healthcare coverage at football games is a common practice in high school; however, because cheerleading is considered an after school activity rather than a sport, RTP guidelines may not apply to cheerleaders and therefore they may not have an AT or healthcare professional present at the time of injury (17). Differences existed by grade level, with freshmen and sophomores more likely to be compliant with guidelines compared with seniors. Potential explanations include increased concern for younger athletes, pressures to allow older athletes to RTP during championships or when college scouts are in the stands. Research is needed to investigate this finding.

Healthcare professionals' availability

Healthcare professionals' presence at the time of concussion differed. They were commonly present when injuries were sustained in competition in boys' sports and for varsity-level athletes. Findings presented here represent the 'best case scenario' as only high schools with an AT available to report data can participate in HS RIO. A recent study found only 70% of public secondary schools indicated some access to an AT with coverage varying from multiple full-time ATs employed by the school to access via contracts with medical facilities for specified games or sports (18,19). The most commonly stated reasons for lack of access were 'cost' and 'too few athletes'. Further research to understand compliance with RTP guidelines at schools without AT coverage is needed. For example, school nurses provide health services in educational settings (20,21) and 86.3% of schools have at least a part-time nurse (20).

Limitations

There are limitations that impact study findings. First, the study sample included only NATA-affiliated ATs, prohibiting comparison to schools without AT coverage. The absence of schools without an AT suggests that estimates of AT presence described in this article are significantly higher than at the national level. Second, the surveillance system used in this study was not established to evaluate specific subsets of healthcare specialists. A specific question will improve description of healthcare specialists. A third limitation is lack of consensus for a universal concussion definition indicating differences in concussion diagnosis across healthcare professionals. All concussions captured by this surveillance system presented with at least one concussion symptom, and physicians were involved with concussion assessment in most cases. A recent publication reported that when compared with physicians, ATs provided comparable injury reports; particularly for concussions (22). A fourth limitation was the inability to definitively determine RTP compliance for half of cases. In HS RIO, both ‘symptom resolution time’ and ‘time until return to play’ were reported as categorical variables with overlapping time frames. To understand this limitation, we conducted a sensitivity analysis by coding those out of play for 10–21 days as compliant with RTP guidelines. Findings revealed similar results to using the categorical classification. In our current analysis, we are confident that we have adequately described RTP compliance for athletes with known symptom resolution and time to RTP. Despite these limitations, this study is the first to describe healthcare coverage for athletes with concussion across high school sports in a national sample and explore how healthcare involvement may influence RTP compliance.

Conclusion

Consensus exists that all athletes should follow RTP guidelines regardless of concussion history, sport, gender or level of play and that no athlete should ever return to play the day of injury. We found only a small percentage (1.1%) of athletes with concussion returned to play the same day with improved compliance in more recent years (2012–2013), demonstrating improved adherence to RTP guidelines (5). Patterns of healthcare provider coverage and compliance with RTP guidelines varied by type of exposure, level of play and gender. Findings support that athletes managed by a healthcare team approach that included an AT and another healthcare professional had higher odds of RTP compliance compared with athletes managed by ATs only. Collaboration between high school personnel and healthcare providers can support healthcare professional involvement to ensure uniformity in best practices for compliance with RTP policies.

Acknowledgments

Declaration of interest

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Table 1.

Concussion rates among high school athletes, by sport, per 10 000 athlete exposures, academic years 2009/2010–2012/2013.

Sport[1]	Number of concussions			Athlete exposures (AEs)			Rate per 10 000 AEs			Rate ratio[2] (95% CI)
	Competition	Practice	Total	Competition	Practice	Total	Competition	Practice	Total	
Boys' football	1440	1050	2490	458 205	2 303 590	2 761 795	31.4	4.6	9.0	6.9 (6.4–7.5)
Boys' soccer	275	58	333	319 451	751 899	1 071 350	8.6	0.8	3.1	11.2 (8.4–14.8)
Girls' soccer	439	74	513	270 245	612 438	882 683	16.2	1.2	5.8	13.4 (10.5–17.2)
Boys' basketball	188	108	296	389 401	910 648	1 300 049	4.8	1.2	2.3	4.1 (3.2–5.2)
Girls' basketball	287	103	390	317 840	716 358	1 034 198	9.0	1.4	3.8	6.3 (5.0–7.9)
Boys' baseball	61	28	89	335 248	631 135	966 383	1.8	0.4	0.9	4.1 (2.6–6.4)
Girls' softball	85	63	148	240 443	468 747	709 190	3.5	1.3	2.1	2.6 (1.9–3.6)
Boys' lacrosse	170	53	223	130 123	287 353	417 476	13.1	1.8	5.3	7.1 (5.2–9.6)
Girls' lacrosse	78	29	107	93 319	202 816	296 135	8.4	1.4	3.6	5.8 (3.8–9.0)
Boys' volleyball[3]	2	0	2	19 345	36 863	56 208	1.0	-	0.4	2.9 (0.4–20.6)
Girls' volleyball	87	61	148	334 734	658 512	993 246	2.6	0.9	1.5	2.8 (2.0–3.9)
Boys' wrestling	183	205	388	253 799	710 051	963 850	7.2	2.9	4.0	2.5 (2.0–3.0)
Girls' gymnastics[3]	2	4	6	10 983	49 797	60 780	1.8	0.8	1.0	2.3 (0.4–12.4)
Boys' ice hockey	145	28	173	81 488	165 452	246 940	17.8	1.7	7.0	10.5 (7.0–15.8)
Girls' field hockey	72	32	104	118 184	253 866	372 050	6.1	1.3	2.8	4.8 (3.2–7.3)
Boys' swimming and diving	1	5	6	61 909	265 584	327 493	0.2	0.2	0.2	0.9 (0.1–7.3)
Girls' swimming and diving	6	5	11	71 513	301 465	372 978	0.8	0.2	0.3	5.1 (1.5–16.6)
Boys' track and field	4	9	13	194 829	812 740	1 007 569	0.2	0.1	0.1	1.9 (0.6–6.0)
Girls' track and field	9	8	17	159 657	667 030	826 687	0.6	0.1	0.2	4.7 (1.8–12.2)
Cheerleading[4,5]	14	128	142	58 089	592 865	650 954	2.4	2.2	2.2	1.1 (0.6–1.9)
Boys' cross country[4]	1	-	1	21 845	107 399	129 244	0.5	-	0.1	5.9 (0.4–94.6)
Total	3549	2051	5600	3 940 650	11 506 608	15 447 258	9.0	1.8	3.6	5.1 (4.8–5.3)

[1] Girls' cross country not displayed because no concussions were reported among 113 000 total AEs.

[2] Rate ratio compares competition to practice for each sport.

[3] Includes school year data from 2009/2010 to 2011/2012.

[4] Includes school year data from 2012/2013.

[5] Cheerleaders sustained 11 concussions during 152 217 performance AE, which were excluded from the analysis.

Table 2.

Difference in healthcare professionals present at the time of concussion by sport-specific variables.

	Healthcare professional present at time of concussion[1] *N* (%)						
Sport specific variable	**AT Only (*N* = 3334)**	**Physician only (*N* = 49)**	**Other healthcare professional only (*N* = 1112)**	**AT and physician (*N* = 293)**	**AT and other healthcare professional (*N* = 72)**	**None (*N* = 580)**	**Total (*N* = 5440)**
Exposure type[2,5]							
Competition	1729 (50.4)	47 (1.4)	1006 (29.3)	284 (8.3)	50 (1.5)	315 (9.2)	3431 (100)
Practice	1595 (79.8)	2 (0.1)	106 (5.3)	8 (0.4)	22 (1.1)	265 (13.3)	1998 (100)
Gender[3,5]							
Male	2475 (64.6)	43 (1.1)	659 (17.2)	281 (7.3)	54 (1.4)	321 (8.4)	3833 (100)
Female	811 (53.1)	6 (0.4)	435 (28.5)	11 (0.7)	18 (1.2)	246 (16.1)	1527 (100)
Play level[4,5]							
Freshman	490 (68.3)	1 (0.1)	133 (18.6)	8 (1.1)	6 (0.8)	79 (11.0)	717 (100)
Junior varsity	1049 (61.2)	10 (0.6)	385 (22.5)	18 (1.1)	33 (1.9)	219 (12.8)	1714 (100)
Varsity	1568 (57.5)	38 (1.4)	576 (21.1)	260 (9.5)	31 (1.1)	255 (9.4)	2728 (100)
Combined[6]	189 (84.0)	0 (0)	10 (4.4)	3 (1.3)	2 (0.9)	21 (9.3)	225 (100)

AT, certified athletic trainer. Examples of other healthcare providers include nurse practitioner, EMT.

[1] 171 concussion were excluded because healthcare professionals present at the time of concussion was unknown.

[2] 11 concussions that did not occur during either practice or competition were excluded.

[3] 80 concussions were excluded due to missing gender.

[4] 56 concussions were excluded due to missing play level.

[5] Statistically significant differences in the distribution of healthcare professionals present at the time of concussion ($p < 0.01$).

[6] Combined includes varsity and junior varsity student athletes.

Table 3.

Type of healthcare professional involved in concussion assessment by type of healthcare professional present at the time of injury.

Healthcare professional involved in concussion assessment[1]	Healthcare professional present at time of concussion[2]					
	AT (only)	Physician (only)	Other healthcare professional only	AT and physician	AT and other healthcare professional	None
AT (only)	977 (29.4)	5 (10.4)	264 (23.9)	40 (13.7)	18 (25.0)	130 (22.5)
AT and neurologist	44 (1.3)	1 (2.1)	16 (1.5)	4 (1.4)	1 (1.4)	10 (1.7)
AT and orthopedic physician	521 (15.7)	9 (18.8)	185 (16.7)	104 (35.5)	12 (16.7)	64 (11.1)
AT and general physician	1447 (43.5)	17 (35.4)	495 (44.8)	119 (40.6)	31 (43.1)	216 (37.4)
AT and other healthcare professional	63 (1.9)	0 (0)	15 (1.4)	0 (0)	2 (2.8)	10 (1.7)
AT, neurologist, and other healthcare professional	161 (4.8)	2 (4.2)	57 (5.2)	15 (5.1)	5 (6.9)	10 (1.7)
Neurologist or prthopedic physician	19 (0.6)	4 (8.3)	9 (0.8)	5 (1.7)	1 (1.4)	18 (3.1)
General physician or pther healthcare professional	85 (2.6)	9 (18.8)	65 (5.9)	6 (2.1)	2 (2.8)	118 (20.3)
AT and concussion specialist[3]	10 (0.3)	1 (2.1)	0 (0)	0 (0)	0 (0)	1 (0.2)
Coach/parent/none	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.2)
Total	3327	48	1106	293	72	578

[1] 14 concussions were excluded from analysis because information about healthcare professional who managed concussion care was missing.

[2] 163 concussions were excluded from analysis because healthcare professionals present at the time of concussion were unknown.

[3] Concussion specialist is identified by the AT as someone who has training in concussion identification.

Table 4.

Concussion outcomes associated with healthcare professional who assessed concussion.[1]

	Healthcare Professional Involved in Concussion Assessment[1]									
Concussion outcome	**AT and concussion specialist[5]**	**AT, neurologist and other healthcare professional[4]**	**AT and neurologist**	**AT and orthopedic physician[2]**	**Neurologist or orthopedic physician**	**AT and general physician[3]**	**General physician or other healthcare professional**	**AT and other healthcare professional**	**AT (only)**	**Total**
Mean number of symptoms										
Mean (95% CI)	5.0 (3.8–6.2)	5.8 (5.4–6.1)	4.7 (4.2–5.2)	5.0 (4.8–5.2)	4.5 (3.8–5.1)	4.6 (4.6–4.7)	3.5 (3.3–3.8)	4.7 (4.2–5.1)	4.2 (4.1–4.3)	4.6 (4.5–4.6)
Made return to play Decision[5]										
N (%)										
AT	3 (25.0)	31 (12.6)	17 (23.6)	194 (21.7)	6 (10.7)	680 (29.9)	35 (12.2)	42 (46.2)	1174 (83.9)	2182 (40.9)
Physician	8 (66.7)	193 (78.5)	44 (61.1)	678 (75.8)	48 (85.7)	1531 (67.2)	225 (78.4)	27 (29.7)	168 (12.0)	2922 (54.8)
Coach	0 (0)	0 (0)	0 (0)	1 (0.1)	0 (0)	9 (0.4)	2 (0.7)	0 (0)	7 (0.5)	19 (0.4)
Official	1 (8.3)	6 (2.4)	1 (1.4)	8 (0.9)	1 (1.8)	20 (0.9)	8 (2.8)	2 (2.2)	20 (1.4)	67 (1.3)
Parent	0 (0)	0 (0)	1 (1.4)	9 (1.0)	0 (0)	9 (0.4)	2 (0.7)	0 (0)	14 (1.0)	35 (0.7)
Athlete	0 (0)	1 (0.4)	0 (0)	2 (0.2)	0 (0)	6 (0.3)	2 (0.7)	0 (0)	4 (0.3)	15 (0.3)
Other	0 (0)	15 (6.1)	9 (12.5)	3 (0.3)	1 (1.8)	22 (1.0)	13 (4.5)	20 (22.0)	13 (0.9)	96 (1.8)
Compliance with RTP Guidelines										
N (%)										
Compliant	7 (58.3)	165 (64.5)	38 (48.7)	302 (33.1)	27 (46.6)	761 (32.0)	103 (33.1)	26 (28.0)	292 (19.8)	1721 (30.9)
Non-compliant	0 (0)	11 (4.3)	4 (5.1)	63 (6.9)	3 (5.2)	285 (12.0)	43 (13.8)	19 (20.4)	388 (26.3)	816 (14.6)
Unknown	5 (41.7)	80 (31.2)	36 (46.2)	547 (60.0)	28 (48.3)	1333 (56.0)	165 (53.1)	48 (51.6)	794 (53.9)	3036 (54.5)

[1] Results were not displayed for a 'Coach/Parent/None/missing' healthcare manager due to small sample size ($N = 20$).

[2] Significantly ($p \leq 0.05$) higher number of reported TBI symptoms than 'AT and General Physician', 'AT only' and 'General Physician or Healthcare Professional'.

[3] Significantly ($p \leq 0.05$) higher number of reported TBI symptoms than 'AT only' and 'General Physician or Healthcare Professional'.

[4] Significantly ($p \leq 0.05$) higher number of reported TBI symptoms than each of the other assessor categories except 'AT and Concussion Specialist'.

[5] Concussion specialist is identified by the AT as someone who has training in concussion identification.

[6] 255 concussions were excluded from analysis because the person responsible for making the return to play decision was missing.

Table 5.

Adjusted odds of complying with current RTP guidelines.[1,2]

Healthcare provider, sport and injury variables[3]	Odds ratio (95% CI)	*p*-Value
Healthcare professional involved in concussion assessment		
Neurologist or orthopedic physician vs. AT (Only)	7.1 (2.0–24.8)	<0.01
General physician or other healthcare professional vs. AT (Only)	2.5 (1.6–4.0)	<0.01
AT, neurologist and other healthcare professional vs. AT (Only)	11.9 (6.1–23.0)	<0.01
AT and neurologist vs. AT (Only)	8.6 (3.0–25.1)	<0.01
AT and orthopedic physician vs. AT (Only)	4.2 (2.9–6.0)	<0.01
AT and general physician vs. AT (Only)	2.8 (2.2–3.7)	<0.01
AT and other healthcare professional vs. AT (Only)	1.9 (1.0–3.7)	0.04
New/recurrent concussion		
Recurrent vs. new	2.2 (1.6–3.2)	<0.01
Sport type		
Collision[4] vs. limited contact[5]	1.5 (1.1–2.0)	0.02
Contact[6] vs. limited contact	1.1 (0.8–1.6)	0.49
Who made return to play decision		
Physician vs. AT	1.3 (1.1–1.7)	0.02
No healthcare professional[7] vs. AT	1.0 (0.6–1.5)	0.94
Academic year		
2010–2011 vs. 2009–2010	1.2 (0.9–1.6)	0.15
2011–2012 vs. 2009–2010	1.6 (1.2–2.1)	<0.01
2012–2013 vs. 2009–2010	2.0 (1.6–2.7)	<0.01
Number of reported symptoms	1.1 (1.00–1.1)	<0.01
Year in school		
Freshman vs. senior	1.7 (1.3–2.2)	<0.01
Sophomore vs. senior	1.7 (1.3–2.3)	<0.01
Junior vs. senior	1.3 (1.0–1.7)	0.08

[1]Only includes concussions identified as compliant or non-compliant ($n = 2549$).

[2] McCrory P, Meeuwisse, W, 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: 250–258.

[3] 56 concussions were excluded from analysis due to missing values for sport/injury response variables.

[4] Football, wrestling, ice hockey and lacrosse.

[5] Baseball, softball, cheerleading, gymnastics, volleyball, track, cross country and swimming.

[6] Basketball, field hockey and soccer.

[7] Coach, parent, athlete or other.