[Athletic Training]

Association Between Previous Concussion History and Symptom Endorsement During Preseason Baseline Testing in High School and Collegiate Athletes

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ABSTRACT

Background: A graded symptom checklist is one commonly used concussion evaluation measure. Little is known about preseason baseline symptomatology of high school and college athletes with and without a previous concussion history.

Hypothesis: The primary hypothesis investigated was the association between prior concussion history and symptom presence at baseline. The effects of gender and age on symptoms were also examined.

Study Design: Cross-sectional study.

Methods: Subjects included 8930 high school and collegiate athletes (height, 177.79 ± 9.97 cm; mass, 75.20 ± 19.21 kg; age, 16.60 ± 1.64 years). Subjects completed a self-report–graded symptom checklist and concussion history questionnaire during a preseason clinical testing session. Symptoms reported (yes or no) on the 18-item graded symptom checklist served as the dependent variables.

Results: A significant association was observed between symptoms on the graded symptom checklist and previous concussion history ($P \leq .001$). No differences were observed between high school and college athletes regarding symptom endorsement ($t_{8928} = 0.620$; $P = .535$). A statistical but not clinically meaningful difference was observed between the means for males and females symptom endorsement ($t_{8928} = -3.03$; $P = .002$): men endorsed 1.88 ± 2.81 symptoms, and women endorsed 2.09 ± 2.90 symptoms. Headache, sleeping more than usual, difficulty concentrating, drowsiness, difficulty remembering, fatigue, difficulty sleeping, and irritability were reported by more than 10% of athletes.

Conclusion: High school and college athletes with a history of multiple concussions may be at risk for experiencing concussion-linked symptoms well beyond the acute stage of injury. Clinicians should be mindful of previous concussion history in athletes with increased presence of base-rate symptoms as they may be predisposed to future injury.

Keywords: preseason baseline; mild traumatic brain injury; symptomatology; concussion

A symptom checklist is one of the most commonly used clinical measures in concussion assessment, as almost 75% of certified athletic trainers employ some form of a symptom checklist in evaluating concussions.[15] The symptom checklist has been used in various studies and has been shown to be a valid and reliable clinical tool.[10,11,17,18] Despite its common and widespread use, little is known about the base-rate presence of common postconcussive symptoms in high school and collegiate athletes. These checklists typically include symptoms such as headache, fatigue, neck pain, and drowsiness. These symptoms are commonly experienced on a regular basis by healthy individuals,[22] again reinforcing the need for an accurate assessment of symptoms both preinjury and postinjury.

Current literature has reinforced the need for "true" baseline assessment of symptoms.[3,12,19] Baseline assessments should be taken seriously, as over- or under-representation of symptoms may influence interpretation of results postinjury. Understanding the typical presentation of symptoms

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Table 1. Graded symptom checklist

Symptom	None	Mild		Moderate		Severe	
Headache	0	1	2	3	4	5	6
Nausea	0	1	2	3	4	5	6
Vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Sleep more than usual	0	1	2	3	4	5	6
Numbness/tingling	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Feeling in a "fog"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Neck pain	0	1	2	3	4	5	6
Fatigue	0	1	2	3	4	5	6
Difficulty sleeping	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6

commonly reported during preseason baseline in individuals with and without a history of concussion may aid clinicians in more accurately interpreting symptoms during postinjury testing when baseline scores are not available. This information may also be useful to physicians or other medical professionals as these individuals do not have access to preseason baseline information when evaluating an athlete postinjury. Knowing an athlete's regular symptomatology may aid the clinician in gauging injury severity and management decisions postinjury.

Symptoms present at baseline may be an indicator of existing conditions or previous history of injury. The presence of these symptoms may also influence neuropsychological performance and again should be taken into account during assessment.[6,19] Recent studies suggest an association between presence of headache at baseline and previous concussion history.[19] The question most frequently asked is whether increased symptomatology at baseline suggests long-term neurological and psychological consequences of recurrent concussion. These effects can range from consistent headache to memory problems and depression. Other consequences may include increased risk and longer recovery of subsequent concussions.[4,23] These deficits can affect activities of daily living, especially schoolwork and attention.[14] Little is known about these cumulative effects in younger athletes and how these effects may be magnified later in life. Suggestions have also been made that these effects are not as prominent in individuals with 1 or 2 previous concussions, but become more evident in individuals suffering from 3 or more.[2] Another set of issues to consider are gender differences concerning symptoms present during baseline testing. Current literature suggests females report a greater number of mild baseline symptoms than males.[5]

Concussion symptomatology is widely used to establish readiness to return to play following concussion; however, postconcussion symptom scores are only as good as the base rates to which they are compared. Therefore, the purpose of this study was to examine the association between prior concussion history and presence of symptoms at baseline. A secondary purpose was to assess the prevalence of preseason baseline symptoms in high school and collegiate athletes and in athletes with a previous concussion history.

METHODS

Institutional review board approval was obtained prior to the initiation of the study. Subjects included 7534 high school athletes and 1396 collegiate athletes (height, 177.79 ± 9.97 cm; mass, 75.20 ± 19.21 kg; age, 16.60 ± 1.64 years). Subjects completed a self-report concussion history questionnaire and an 18-item graded symptom checklist (GSC) (Table 1) during a preseason baseline assessment session as part of a larger clinical study. Using a GSC, subjects were asked to rate the presence and severity of symptoms experienced 3 or more days per week on a regular basis. This symptom checklist has been used and recommended in the literature.[1,8] The concussion history questionnaire asked subjects to report the number of previous concussions experienced. Both instruments were administered to subjects by the certified athletic trainer at his or her school. Certified athletic trainers were trained in administration of the instruments prior to the start of the research study.

Statistical Analysis

Subjects were stratified into 1 of 3 concussion history groups: no history of concussion (n = 6886), history of 1 or 2 previous concussions (n = 1942), or a history of 3 or more previous concussions (n = 102). Descriptive data were obtained, including the prevalence of symptoms in high school and college athletes, as well as symptom prevalence in high school and college athletes grouped according to concussion history. Independent samples t test were conducted to examine differences in symptoms endorsed between males and females and between high school and college athletes.

Separate chi-square tests of association were used to assess the association between presence of symptoms and previous history of concussion. Alpha (α) level was set to 0.05 a

Table 2. Prevalence of symptoms in high school and college athletes, and across concussion history groups

Symptom, %	High School (n = 7534)	College (n = 1396)	No History (n = 6886)	History 1-2 (n = 1942)	History 3+ (n = 102)
Headache	25.7 (1939)	23.4 (326)	22.9 (1574)	32.9 (638)	52.0 (53)
Nausea	6.6 (501)	6.2 (86)	6.0 (416)	8.2 (159)	11.8 (12)
Vomiting	2.3 (172)	1.7 (24)	1.8 (127)	3.2 (63)	5.9 (6)
Dizziness	10.0 (752)	7.1 (99)	8.1 (561)	13.7 (266)	23.5 (24)
Fatigue	21.3 (1605)	27.1 (378)	20.7 (1425)	26.8 (520)	37.3 (38)
Trouble sleeping	15.7 (1181)	16.9 (236)	14.6 (1005)	19.6 (381)	30.4 (31)
Sleeping more than usual	12.5 (945)	15.3 (213)	12.1 (831)	15.9 (309)	17.6 (18)
Drowsiness	16.8 (1264)	17.0 (238)	15.6 (1072)	20.8 (404)	25.5 (26)
Sensitivity to light	5.8 (438)	6.3 (88)	5.0 (347)	8.9 (172)	6.9 (7)
Blurred vision	5.7 (431)	5.4 (76)	4.7 (324)	8.5 (165)	17.6 (18)
Sensitivity to noise	3.4 (256)	2.9 (40)	2.8 (193)	5.0 (97)	5.9 (6)
Sadness	6.3 (476)	7.8 (109)	6.1 (421)	7.7 (150)	13.7 (14)
Irritability	12.4 (932)	14.5 (202)	11.6 (799)	15.9 (309)	25.5 (26)
Numbness	4.7 (352)	3.9 (55)	3.9 (271)	6.5 (126)	9.8 (10)
Feeling in a "fog"	4.0 (310)	5.2 (73)	3.5 (243)	5.9 (115)	15.7 (16)
Trouble concentrating	15.8 (1197)	15.8 (221)	13.8 (949)	21.5 (417)	41.2 (42)
Trouble remembering	12.3 (928)	12.4 (173)	10.7 (737)	17.1 (332)	31.4 (32)
Neck pain	12.0 (907)	9.5 (133)	10.5 (720)	15.0 (292)	27.5 (28)

Table 3. Association[a] between presence of symptoms and previous history of concussion.[b]

Cluster	Symptom	χ^2(3 *df*)	*P* Value
Somatic	Headache	118.50	<.001
	Nausea	15.90	<.001
	Vomiting	20.37	<.001
	Sensitivity to light	40.00	<.001
	Blurred vision	68.26	<.001
	Sensitivity to noise	24.83	<.001
	Numbness/tingling	29.22	.001[c]
	Neck pain	55.93	<.001
	Dizziness	77.58	<.001
Cognitive	Drowsiness	35.22	<.001
	Feeling in a "fog"	55.61	.001[c]
	Difficulty concentrating	117.60	<.001
	Difficulty remembering	91.89	<.001
	Fatigue	45.97	<.001
Emotional	Sadness	15.09	.001
	Irritability	40.59	<.001
Sleep-related	Difficulty sleeping	44.95	<.001
	Sleeping more than usual	21.83	<.001

[a] All associations were significant.
[b] *df*, degrees of freedom.
[c] Indicates Fisher's exact *P* value reported as 1 cell had an expected value of less than 5.

priori. Based on previous literature,[16] we divided the 18 symptoms into 4 distinct categories: somatic, cognitive, emotional, and sleep problems. In order to minimize Type I errors while running multiple chi-square analyses, our a priori α level was adjusted for the number of symptoms classified within a particular cluster. The a priori α values for the groups were as follows: cognition (0.01), somatic (0.0056), emotional (0.025), and sleep problems (0.025).

RESULTS

Nine of the 18 symptoms on the GSC were endorsed by at least 10% of our sample (Table 2). Further, the prevalence was greater for all of the symptoms in individuals reporting a history of concussion compared to those with no preexisting history of concussion (Table 2). Nearly 23 percent of subjects (2044/8930) reported at least 1 previous concussion. There was a statistical difference in number of symptoms endorsed at preseason baseline between males (1.88 ± 2.81) and females (2.09 ± 2.90) ($t_{8928} = -3.03$; $P = .002$). The effect size for this analysis was 0.07, suggesting this statistical difference was clinically insignificant.

There was no difference in symptoms endorsed between high school and college athletes ($t_{8928} = 0.620$; $P = .535$). Therefore, these 2 groups were combined for the analyses of association between each symptom and previous concussion history. There was a significant association between presence of each symptom at baseline and previous history of concussion ($P < .001$) (Table 3). These results are magnified in individuals with a history of 3 or more concussions.

DISCUSSION

The main finding of our study is the association between the presence of reported baseline symptoms

on the GSC and a previous history of concussion. Consistent with current literature, this finding was magnified in individuals with a history of 3 or more concussions.[7,20,21] Half of the 18 symptoms were present in 25% of those with 3 or more concussions, while no symptoms were reported by more than 23% in the group with no history of concussion (Table 2). Our results agree with previous research findings which suggest that long-term effects of multiple concussions, such as experiencing an increase in symptoms on a regular basis, may exist. Studies have also suggested acute effects, including more on-field markers of severity and increased susceptibility to future injury.[4]

More than 10% of high school and collegiate athletes reported a variety of the symptoms on the checklist during a baseline testing session. One possible explanation for the overall elevation of symptoms may have been the time at which these symptoms were assessed by the various athletic trainers. This increased presence of symptoms should remind clinicians to be vigilant about the source of these symptoms, including dehydration, difficult or long practices, or other conditions such as depression.

These findings are important as our sample represents both high school and college student-athletes, and they underscore the importance of considering base-rate symptoms in the management of athletes both pre- and postconcussion. These individuals require a high level of attention and concentration to be successful in their academic settings. Both age groups reported relatively high prevalence of difficulty concentrating in conjunction with headache and fatigue, all of which may affect performance in school. As previously mentioned, this prevalence was magnified in individuals with a history of concussion. A previous study indicated significant differences in grade point average (GPA) in high school athletes with no history of concussion and individuals with a history of concussion as well as decreased neuropsychological performance.[14] Our data suggests that athletes with a history of concussion experience more symptoms on a regular basis. We hypothesize that these symptoms may confound their ability to perform academically and in activities of daily living. These data provide an important look into the effects of multiple concussions in both high school and collegiate athletes.

These data also suggest minimal effects of gender on presentation of symptoms at preseason baseline, which is consistent with current literature. One previous study[5] reported statistically significant differences between males and females regarding symptom score (0-6 based on severity) for each item on a GSC during a baseline test session, but these findings also were not clinically significant, with the largest difference between males and females on any symptom being 0.56, and the difference in total symptom score only being 1.46, with female subjects reporting slightly more mild symptoms. The variable included in our study was also slightly different as we used total number of symptoms endorsed, regardless of severity. As with the aforementioned study, although our finding was statistically significant, it was not clinically significant and should be interpreted with caution. No differences were observed in total number of symptoms endorsed between high school and college athletes during preseason baseline.

Limitations

A discussion of limitations as they pertain to our study is warranted. Self-reporting serves as a limitation to any study using GSC. This information is often difficult to ascertain objectively. However, recent studies have shown youth to be reliable in reporting symptoms on a symptom scale.[11] Although all subjects were assessed during a preseason baseline test session, this is a time of increased practice and intensity for athletes. An increase in physical exertion could increase many of these symptoms. Individuals with a history of previous concussion still exhibit an increased prevalence of all symptoms assessed on the GSC. Also, the self-report of concussion history is quite possibly an underestimate given that nearly 75% of athletes may not be able to identify signs and symptoms of a concussion,[9] while the literature suggests that more than 50% of concussions may go unreported.[13] Unfortunately, we also do not have the timeframe for the concussion history, which could have influenced our findings. Lastly, given there is no gold standard for concussion identification, these methods appear to be justified because there is a clear difference between individuals reporting a previous concussion and individuals who were free of concussion.

CONCLUSION

In summary, clinicians should be mindful of typical symptoms at baseline, specifically in individuals reporting a history of concussion. These baseline values should be taken into account when evaluating an athlete postinjury. Individuals reporting a high number or severity of symptoms during baseline testing require careful screening, as the presence of these symptoms may serve as an indicator of underlying pathology. Athletes with increased rate of baseline symptoms may be predisposed to future injury. Most importantly, athletes with a history of 3 or more concussions may be at risk for cumulative intermediate, if not long-term, effects.

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