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Post-Concussion Symptoms of Depression and Anxiety in Division I Collegiate Athletes

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This study examined the effect of baseline psychological symptoms on post-concussion symptoms among 67 concussed collegiate athletes. Depression at baseline was the strongest predictor of post-concussion depression and anxiety. Post-concussion depression and anxiety were significantly associated. These results support the importance of baseline screenings for risk of post-concussion psychological symptoms.

Each year, college athletes experience over 12,500 injuries while participating in National College Athletic Association (NCAA) sponsored sports (Hootman, Dick, & Agel, 2007). These injuries frequently lead to an immediate disruption in the athlete's life, affecting not only physical health but also psychological well-being caused by depression, anxiety, tension, fear, and/or low self-esteem (Wiese-Bjornstal, 2010). Although a concussion often has no outward physical damage, psychological symptoms resulting from a concussion could stem from both brain tissue damage as well as from psychosocial sequelae (Bloom, Horton, McCrory, & Johnston, 2004).

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A growing body of literature documents the negative psychological consequences of concussions (Hart et al., 2013; McCrory, Meeuwisse, Aubry, et al., 2013; McCrory, Meeuwisse, Kutcher, Jordan, & Gardner, 2013). However, few prospective studies have investigated pre- and post-concussion depression and anxiety in collegiate athletes. Information on pre-concussion psychological symptoms could improve understanding of the psychological impact of concussions. This study examined the effect of baseline psychological symptoms on post-concussion depression and anxiety among a sample of concussed Division I collegiate athletes. We hypothesized that concussed athletes who experienced symptoms of depression and/or anxiety at baseline were more likely to report symptoms of depression and/or anxiety post-concussion compared to athletes who had no symptoms of depression and/or anxiety at baseline.

METHODS

Study Design and Participants

A prospective cohort study with repeated measures was conducted. Male and female athletes who attended two Big Ten Conference universities and participated in nine sports teams were recruited during the 2007–08 to 2011–12 seasons. The nine teams included: men's football, wrestling, basketball, and baseball, and women's basketball, softball, soccer, field hockey, and volleyball.

Following consent, baseline data including symptoms of depression and anxiety were collected in person from all enrolled athletes. Enrolled athletes were then followed to identify injury incidence through the Sports Injury Monitoring System (SIMS), an injury surveillance database used by NCAA universities. SIMS is updated daily by team certified athletic trainers. Upon report of an injury, follow-up surveys of an injured athlete were conducted at multiple intervals until his/her return-to-play (e.g., as many as 5 surveys depending on injury length: 1 week, and 1, 3, 6, and 12 months), to measure post-injury symptoms of depression and anxiety. This analysis included data from baseline and one-week post-injury surveys for 71 concussions (63 athletes sustained one concussion and 4 sustained two concussions during the study period). All study and consent procedures were approved by the Institutional Review Board at the respective universities.

Study Measures

A *concussion* was defined as a trauma-induced alteration of mental status, occurring in sport activities (game or practice), regardless of whether the injury resulted in the restriction of the student-athlete's participation (Harmon et al., 2013). Diagnosis was made by team physicians.

Symptoms of depression, measured both at baseline and post-concussion, were assessed using the Center for Epidemiological Studies Depression (CESD) Scale (Radloff, 1991). The CESD was validated with college students, with internal consistency alpha ranging from .84 to .90 (Radloff, 1991).

Anxiety was measured by the State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), which includes 20 items measuring state-anxiety and 20 items of trait-anxiety. Trait anxiety was measured at baseline, and state anxiety was measured at follow-up.

High concurrent validity was found between the State-Trait Anxiety Inventory and other scales that measure anxiety, with correlation ranging from 0.73 to 0.85 (Spielberger et al., 1983).

Other variables measured on the baseline survey included: gender, sport, race, year in school, and whether an athlete had any difficulties with their current course work. Return to play was recorded through the SIMS database. Because life factors are such an important predictor of depression and anxiety, we measured major life events the athletes experienced 12 months prior to their concussion. We used the modified 47-item Holmes and Rahe Social Readjustment Rating Scale, and collected the data one week following the concussion (Holmes & Rahe, 1967).

Data Analysis

We used generalized estimation equation regression models to assess the effect of baseline psychological symptoms on post-concussion symptoms of depression and anxiety, adjusting for the summary score of major life events. Models were clustered by athlete to account for the four athletes who had multiple concussions. All of the analyses were conducted using SAS 9.2.

RESULTS

Approximately three-quarters of the 71 concussions were sustained by male athletes (n = 53, 74.6%) (Table 1). Over half of all concussions were incurred by football players (n = 42, 59.2%). About two-thirds of concussed athletes (n = 45, 63.3%) returned to play less than one week following the concussion. Approximately one-fifth of concussed athletes (n = 14, 19.8%) reported experiencing symptoms of depression, and over one-third (n = 24, 33.8%) reported experiencing anxiety. Ten (14.1%) concussed athletes reported experiencing both depression and anxiety.

Concussed athletes who had symptoms of depression at baseline (pre-injury) were 4.59 times more likely (95% CI = 1.25, 16.89) to experience depression symptoms and 3.40 times more likely to (95% CI = 1.11, 10.49) experience state anxiety following the concussion, compared to concussed athletes who had no symptoms of depression at baseline. However, concussed athletes with baseline (pre-injury) trait anxiety did not have increased post-concussion depression and state anxiety symptoms. Furthermore, post-concussion symptoms of depression significantly co-occurred with post-concussion state anxiety (OR = 8.35, 95% CI = 2.09, 33.34).

DISCUSSION

This study found that depression at baseline was the strongest predictor for post-concussion depression, and predicted post-concussion state anxiety. Co-occurring depression and anxiety were common post-concussion. Since the concussion history of collegiate athletes is not always known, it is possible that the baseline depression observed in this study is a function of previous unrecognized neurologic concussive damage (Hart et al., 2013). Our findings support the need and importance for baseline screenings to identify athletes who are at high risk for post-concussion psychological symptoms. Baseline measures could also help differentiate athletes who have newly emerging post-concussive symptoms. Consensus standards increasingly call for

TABLE 1
Post-Concussion Symptoms of Depression and Anxiety (n = 71)

		Post-Concussion Depression		*Post-Concussion Anxiety*	
	N	*n (%)*	*OR (95% CI)*[1]*	*n (%)*	*OR (95% CI)*[1]*
Gender					
Male	53	11 (20.8)	2.03 (0.51, 8.14)	19 (35.9)	1.58 (0.43, 5.87)
Female	18	3 (16.7)		5 (27.8)	
Sport					
Football	42	11 (26.2)	**4.33 (1.14, 16.47)[2]**	17 (40.5)	2.30 (0.75, 7.05)
Other sports	29	3 (10.3)		7 (24.1)	
Race					
White	52	9 (17.3)	0.50 (0.13, 1.89)	14 (26.9)	0.33 (0.10, 1.04)
Non-white	19	5 (26.3)		10 (52.6)	
School Year at Injury					
Freshman	17	8 (47.1)	**5.95 (1.60, 22.14)[2]**	5 (29.4)	0.71 (0.21, 2.40)
Other	54	6 (11.1)		19 (35.2)	
Baseline Depression					
Yes	18	7 (38.9)	**4.59 (1.25, 16.89)[2]**	10 (55.6)	**3.40 (1.11, 10.49)[2]**
No	53	7 (13.2)		14 (26.4)	
Baseline Anxiety					
Yes	40	10 (25.0)	2.92 (0.73, 11.70)	15 (37.5)	1.55 (0.56, 4.31)
No	31	4 (12.9)		9 (29.0)	
Difficulties with Current Course Work					
Yes	24	7 (29.2)	2.87 (0.82, 9.99)	9 (37.5)	1.38 (0.48, 3.92)
No	47	7 (14.9)		15 (31.9)	
Post-concussion Depression					
Yes				10 (71.4)	**8.35 (2.09, 33.34)[2]**
No				14 (24.6)	
Post-concussion Anxiety					
Yes	24	10 (41.7)	**8.20 (2.09, 32.21)[2]**		
No	47	4 (8.5)			

*OR = Odds Ratio; 95%CI = 95% Confidence Interval.
[1]Adjusted for life-events experienced in the12 months prior to concussion. [2]Statistically significant at $\alpha = .05$ level.

thorough pre-season neuropsychological assessments (McCrory, Meeuwisse, Aubry, et al., 2013), and as these are implemented, the ability to identify high-risk players will increase.

While an increasing body of literature is recognizing a high prevalence of depressive symptoms following concussion, whether symptoms of depression are caused by brain cell damage from the concussion itself, and/or the injured player's ineffective coping with the injury remains unclear (Bloom et al., 2004). Further studies are warranted to investigate the root causes

of post-concussion depression and anxiety. Athletes with pre-injury depressive symptoms could be considered a vulnerable group and a focus for interventions aimed to prevent and/or reduce post-concussion symptoms (Harmon et al., 2013). These interventions need to consider strategies that effectively address both short-term and long-term psychological sequelae.

Associations between baseline anxiety and post-concussion anxiety were not statistically significant. It is possible that trait-anxiety measured at baseline would differ from state anxiety, which potentially biased the observed associations. We did find that baseline depression was associated with post-concussion state anxiety, which could indicate that, regardless of trait anxiety, depression leads to increased post-concussion state anxiety.

This study had a limited sample size. Some concussions may not have been reported in this study, as concussion is often under-reported. Despite these limitations, the results of this study provide empirical evidence on the role of baseline psychological symptoms in post-concussion depression and anxiety and call for programs to effectively address both psychological predictors and consequences of concussions.

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