

Exploration of the relationship between concussions and depression symptoms, anxiety symptoms and hazardous drinking among a sample of college students

Ryan J. Martin, PhD and Beth H. Chaney, PhD

Ryan J. Martin, PhD, Department of Health Education and Promotion, East Carolina University,
martinry@ecu.edu

Beth H. Chaney, PhD, Department of Health Education and Promotion, East Carolina
University, chaneye@ecu.edu

Corresponding Author:

Ryan J. Martin, PhD

Department of Health Education and Promotion

3106 Carol Belk Building

East Carolina University

Greenville, NC 27858 (USA)

Email: martinry@ecu.edu

Phone: (252) 737-1939

Fax: (252) 328-1285

Abstract

Objective: In clinical and athlete populations, research has found that experiencing a concussion (or traumatic brain injury) is correlated with experiencing other psychiatric conditions, including depression and alcohol problems. However, less is known about concussion co-morbidity in other population segments. The purpose of this study is to examine the relationships between concussions and depression symptoms, anxiety symptoms, and hazardous drinking among a large sample of college students ($N = 1776$) enrolled in a mandatory health course. **Methods:** This study used an online health survey to examine concussion frequency (informal and formal diagnoses), sports-related concussions, depression symptoms, anxiety symptoms, and hazardous drinking in our sample. Bivariate and multivariate analyses were conducted to examine co-morbid relationships between concussion frequency and the dependent variables of interest (anxiety symptoms, depression symptoms, hazardous drinking). **Results:** We found that 691 (39.1%) participants indicated having at least one concussion. Analyses indicated that concussion frequency scores of both formal or informal diagnoses were significantly associated with scores of depression symptoms, anxiety symptoms and hazardous drinking. When examining concussion frequency scores of only formal diagnoses, only hazardous drinking evidenced a statistically significant relationship. In addition, participants who had a sports concussion had significantly higher concussion frequency scores and hazardous drinking scores than those who have had a concussion that was not sport-related. **Conclusions:** The co-morbid concussion relationships found in this study are consistent with those observed in clinical and athlete populations. It is important for college health professionals to be aware that concussion co-morbidity is not limited to the athlete population and can impact the entire student body.

Keywords: *Concussion; depression; hazardous drinking; anxiety; co-morbidity; college students*

Introduction

A concussion has been defined as a “complex pathophysiological process affecting the brain induced by biomechanical forces” (McCrorry et al., 2013, p. 250). Concussion and traumatic brain injury (TBI) are sometimes used interchangeably, but a concussion is often considered a mild traumatic brain injury. Common features of concussions include: being caused by a direct blow to the head, face, neck, or elsewhere in the body with an impulsive force transmitted to the head; rapid onset of short term impairment of neurological function that resolves spontaneously; and a graded set of clinical syndromes that may or may not involve loss of consciousness (McCrorry et al., 2013). Signs and symptoms of concussions include headaches, vomiting, confusion, irritability, arm and leg numbness or seizures, unsteadiness when walking, sleep disturbances, and slurred speech (McCrorry et al., 2005).

Co-morbidity refers to the co-occurrence of mental and physical disorders in the same person, regardless of the chronological order in which they occurred or the causal pathway linking them (Druss & Reisinger-Walker, 2011). Reviews of concussion studies have found correlations between experiencing a concussion (or TBI) and other psychiatric conditions (Broshek, DeMarco, & Freeman, 2015; Scholten et al., 2016). In clinical samples, co-morbid relationships have been found between experiencing a concussion (or TBI) and depression (Bay & Donders, 2008; Bombardier et al., 2010; Dikmen, Bombardier, Machamer, Fann, & Temkin, 2004; Hudak et al., 2011; McCauley, Boake, Levin, Contant, & Song, 2001; Whelan-Goodinson, Ponsford, Johnston, & Grant, 2009), experiencing a concussion (or TBI) and anxiety (Dischinger, Ryb, Kufera, & Auman, 2009; Ponsford et al., 2012; Whelan-Goodinson et al., 2009), and experiencing a concussion (or TBI) and alcohol-related problems (Bombardier, Temkin, Machamer, & Dikmen, 2003; Jorge et al., 2005; Ponsford, Whelan-Goodinson, &

Bahar-Fuchs, 2007). Co-morbid relationships between experiencing a concussion (or TBI) and depression have also been found in athlete populations, both college (Roiger, Weidauer, & Kern, 2015; Vargas, Rabinowitz, Meyer, & Arnett, 2015; Yang, Peek-Asa, Covassin, & Torner, 2015) and professional (Guskiewicz et al., 2007).

While the co-morbid relationship between concussions and depression has been studied extensively in the college athlete population, less is known about the epidemiology (prevalence, risk factors) of concussion co-morbidity in general populations of college students and adolescents. We located one study that found a strong association between concussions and depression in the general adolescent (i.e., 12-17 years old) population (Chrisman & Richardson, 2014). In contrast, we found one study among a sample of college students that found that participants who experienced concussions (or TBI) were significantly less likely to experience depression and irritability compared to their counterparts who had not experienced a concussion (Krause & Richards, 2014).

To date, there is limited research to examine the co-morbid relationships between experiencing a concussion and hazardous drinking, anxiety and depression among college student populations. Most concussion co-morbidity studies among college students have focused on depression in the student athlete population. Given the lack of understanding of these relationships in college student populations, the purpose of this study is to assess experiencing a concussion, hazardous drinking, symptoms of anxiety and depression and the co-morbid relationship of those behaviors among a large convenience sample of college students ($N = 1,766$) in a mandatory health course via a cross-sectional online health survey. Specifically, we examined the following:

1. Whether the co-morbid relationship between concussions and depression symptoms found in college athlete samples exists in a sample of general population college students.
2. Whether there is a co-morbid relationship between concussions and anxiety symptoms in a sample of general population college students.
3. Whether there is a co-morbid relationship between concussions and hazardous drinking in a sample of general population college students.
4. Whether these co-morbid relationships vary by whether the concussions were formally diagnosed.
5. Whether there are differences in concussion frequencies between those who experienced a sport-related concussion and those who have experienced a concussion that was not sports-related.

Methods

This study was conducted in Spring 2015 and received approval from the Institutional Review Board (IRB) of the university at which the research was conducted. The study was monitored by the same IRB board and conducted in accordance with the Declaration of Helsinki. We assessed concussion diagnoses, hazardous drinking (via AUDIT-C scores), depression symptoms (via PHQ-9 scores) and anxiety symptoms (via GAD-7 scores) among a large convenience sample of college students via a cross-sectional online health survey. Our measures, which are discussed in detail in the subsequent Measures section, were incorporated into the online health survey in the Spring 2015 semester. Undergraduate students enrolled in a required health course were recruited by in-class and email announcements during the semester. An email invitation requesting student volunteers to complete the anonymous, online survey, administered via Qualtrics© (Provo, UT), was sent to all enrolled students. Before taking the online health

survey, participants provided their consent electronically. That consent section informed participants that their participation was voluntary, their responses were anonymous, and they could withdraw from the study at any time.

Participants/Setting

The participants in this study were a convenience sample of undergraduate students who were enrolled in an introductory health course at a large, Southeastern university in Spring 2015 and chose to complete a non-mandatory online health survey. All students taking the introductory health course were provided the opportunity to complete the online survey for extra course credit. Participants completed the survey on their own time using either a personal computer or campus computer. The online health survey was active for seven days, and participants could complete the survey at any time throughout that timeframe.

Of the 2,282 students enrolled in the personal health course in Spring 2015, 1,841 (80.7%) completed or partially completed the optional online health survey. Using the listwise deletion function in Statistical Package for the Social Sciences (SPSS version 22), we removed participants who failed to complete one or more of the measures in the survey ($n = 75$). Thus, a sample of 1,766 students was used for this analysis.

Measures

Participants completed the online health survey, which included measures to assess concussions, hazardous drinking, and symptoms of anxiety and depression. In addition, demographic measures were assessed, including gender, race, age, and class status. The athlete status of participants was not assessed. The vast majority of students in the personal health course were not college athletes, but all students at this institution, including athletes, were

required to take the course. Thus, some participants were college athletes, but we were not able to identify them as such.

Concussions: We used two questions from a previous study (Torres et al., 2013) to assess concussions: *How many times have you formally been diagnosed with a concussion? How many times have you suspected a concussion without a formal diagnosis?* For each question, participants could select 0, 1, 2, 3, 4, or 5 or more (“5 or more” was a choice; respondents did not have the option to write in any number). We treated these count item variables as concussion frequency scores, with one score for all diagnoses (formal and informal) and one score for formal diagnoses only. In addition, participants who experienced a concussion were presented with the following yes/no question concerning sports-related concussions: *Did any of your concussions occur when you were playing sports?* We did not assess whether the sports-related concussion occurred during formal or informal sports or whether the sport-concussion(s) was diagnosed formally.

Hazardous drinking: To assess hazardous drinking, we used the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C) screen (Bush, Kivlahan, McDonnell, Fihn, & Bradley, 1998), which includes the first three consumption items from the AUDIT (Saunders, Aasland, Barbot, de la Fuente, & Grant, 1993). Each item has five response options, and the options are coded 0-4. We summed the AUDIT-C items to create a hazardous drinking sum score, which we treated as a continuous variable.

Anxiety: We assessed anxiety symptoms via the 7-item Generalized Anxiety Disorder scale (GAD-7) (Spitzer, Kroenke, Williams, & Lowe, 2006). Each item has four response options, and the options are coded 0-3. We summed the GAD-7 items to create an anxiety sum score, which we treated as a continuous variable.

Depression: We assessed depression symptoms via the 9-item Patient Health Questionnaire Depression scale (PHQ-9) (Kroenke & Spitzer, 2002; Kroenke, Spitzer, & Williams, 2002). Each item has four response options, and the options are coded 0-3. We summed the PHQ-9 items to create a depression sum score, which we treated as a continuous variable.

Statistical Analyses

We used SPSS to conduct our analyses. To assess sample characteristics (i.e., gender, race, age, class status), basic descriptive statistics were calculated. Next, the proportion of participants who reported concussions (formal and informal diagnoses, formal diagnoses only, and sport-related) was calculated.

Bivariate analyses: We used ANOVA tests to examine mean score differences for concussion frequencies (formal and informal diagnoses), concussion frequencies (formal diagnoses only), hazardous drinking, depression symptoms, and anxiety symptoms for the following groups: sports concussion status (no concussions, concussion diagnosis but not sport-related, concussion diagnosis where at least one was sport-related), gender, and race (White, non-White). Bonferroni correction was used to examine differences between the three sports concussion status groups.

Multivariate analyses: Two series of linear regression analyses were conducted to examine associations between concussion frequency and the three dependent variables of interest: hazardous drinking, depression symptoms, and anxiety symptoms. The first series of analyses used concussion frequency scores (formal and informal diagnoses) as an independent variable while controlling for gender and race. The second series of analyses used concussion

frequency scores (formal diagnoses only) as an independent variable while controlling for gender and race.

Results

The majority of participants were female (61.5%), White (69.3%), underclassmen (i.e., in their first or second year of college; 90.6%) and either 18 or 19 years of age (80.2%). Overall, 380 (21.5%) participants have had a formal concussion diagnosis, and 574 (32.5%) indicated that they suspected they had a concussion but were not formally diagnosed. The formal and informal diagnosis groups were not mutually exclusive. In total, 691 (39.1%) participants indicated having at least one concussion (formal and informal diagnoses). Among those who experienced a concussion, 458 (66.3%) experienced one or more sport-related concussion. Mean scores for concussion frequencies (formal and informal diagnoses), concussion frequencies (formal diagnoses only), hazardous drinking, depression symptoms, and anxiety symptoms by sports concussion status, gender, and race are listed in Table 1.

Table 1 here

Bivariate results

Bivariate differences by sports concussion status. ANOVA tests with Bonferroni correction indicated that those who had a sports concussion had significantly higher ($p < .001$) concussion frequency scores (both formal and informal diagnoses combined and formal diagnoses only) than those who have had a concussion that was not sport-related. In addition, those with a sports concussion had significantly higher ($p < .001$) hazardous drinking scores than the other two groups. Finally, those who have had concussion that was not sport-related had significantly higher ($p < .001$) depression symptom scores than the other two groups and significantly higher ($p = .006$) anxiety symptoms scores than the no concussion group.

Bivariate differences by gender and race. ANOVA tests indicated that males had significantly higher concussion frequency scores, both formal and informal diagnoses ($p < .001$) and formal diagnoses only ($p = .010$). Males also had significantly higher ($p < .001$) hazardous drinking scores, whereas females had significantly higher ($p < .001$) depression scores and anxiety scores. ANOVA tests indicated that White participants had significantly higher ($p < .001$) concussion frequency scores (both formal and informal diagnoses combined and formal diagnoses only) than non-White participants.

Multivariate results

Using formal and informal concussion diagnoses. The series of linear regression analyses to examine associations between hazardous drinking scores, depression symptom scores, and anxiety symptom scores by concussion frequency scores (formal and informal diagnoses) while controlling for gender and race are listed in Table 2. The model examining hazardous drinking was statistically significant ($F(3, 1762) = 74.6, p < .001$) and explained 11.3% of the variance in hazardous drinking scores. In this model, gender (male), race (White), and concussion frequency score were all significantly positively associated ($p < .001$) with hazardous drinking scores. The model examining depression was statistically significant ($F(3, 1762) = 19.1, p < .001$) and explained 3.1% of the variance in depression symptom scores. In this model, gender (female) and concussion frequency score were both significantly positively associated ($p < .001$) with depression symptoms. The model examining anxiety was statistically significant ($F(3, 1762) = 26.4, p < .001$) and explained 4.3% of the variance in anxiety symptom scores. In this model, gender (female) and concussion frequency score were both significantly positively associated ($p \leq .001$) with anxiety symptoms.

Table 2 here

Using formal concussion diagnoses only. The series of linear regression analyses to examine associations between hazardous drinking scores, depression symptom scores, and anxiety symptom scores by concussion frequency scores (formal diagnoses only) while controlling for gender and race are listed in Table 3. The model examining hazardous drinking was statistically significant ($F(3, 1762) = 61.2, p < .001$) and explained 9.5% of the variance in hazardous drinking scores. In this model, gender (male), race (White), and concussion frequency score were all significantly positively associated ($p < .001$) with hazardous drinking scores. The model examining depression was statistically significant ($F(3, 1762) = 15.5, p < .001$) and explained 2.6% of the variance in depression symptom scores. In this model, only gender (female) was significantly positively associated ($p < .001$) with depression symptoms. The model examining anxiety was statistically significant ($F(3, 1762) = 23.1, p < .001$) and explained 3.8% of the variance in anxiety symptom scores. In this model, only gender (female) was significantly positively associated ($p < .001$) with anxiety symptoms.

Table 3 here

Discussion

When examining both formal and informal concussion diagnoses, we found statistically significant co-morbid relationships between concussion frequency scores and hazardous drinking, depression symptoms, and anxiety symptoms in our sample of college students. When examining only formal diagnoses, we found that only hazardous drinking was significantly associated with concussion frequency scores. Taken together, these findings indicate that the co-morbid relationships between concussion frequency and the dependent variables of interest (hazardous drinking, depression, and anxiety) in this sample are not necessarily stronger with a formal concussion diagnosis.

In our examination of sports-related concussions, we found that those who experienced one or more sports-related concussions reported more concussions than those who had experienced a concussion that was not sport-related. Those who had a sport-related concussion also evidenced higher hazardous drinking scores than other participants. These findings show a strong relationship between concussion frequency and hazardous drinking in this sample, especially among those who had one or more sports-related concussion.

Consistent with our findings, co-morbid relationships between concussions and depression, anxiety and hazardous drinking have been observed in clinical samples (Bay & Donders, 2008; Bombardier et al., 2010; Bombardier et al., 2003; Dikmen et al., 2004; Hudak et al., 2011; Jorge et al., 2005; McCauley et al., 2001; Ponsford et al., 2007; Whelan-Goodinson et al., 2009) and co-morbid relationships between concussions and depression have been found in college athlete samples (Roiger et al., 2015; Vargas et al., 2015; Yang et al., 2015). While our findings are consistent with findings of previous research linking concussions to depression, anxiety and alcohol-related problems, they contrast with the results of the other concussion co-morbidity study among college students in the literature (Krause & Richards, 2014). These contrasting findings might be a result of methodological differences, as our study used scales with multiple items to assess depression and anxiety, whereas Krause and Richards (2014) used a yes/no question to assess if participants were experiencing depression and a yes/no question to assess if participants were experiencing irritability. Further, participant recruitment varied between studies, as our study used in-class announcements, while Krause and Richards used a campus-wide email.

This study expands on previous concussion co-morbidity research by illustrating that co-morbid relationships between depression, anxiety, and alcohol-related problems are not

necessarily limited to clinical samples and athlete samples. Although this is a cross-sectional study and causal relationships cannot be determined, these findings have potential implications for college health professionals, including the consideration of experiencing a concussion as a potential risk factor for depression, anxiety, and alcohol-related problems. Further, in college health clinics, it might be advisable to screen for depression, anxiety, and alcohol-related problems when students present with a concussion. Future research examining concussion co-morbidity should consider examining additional psychological conditions that might be co-morbid with concussions, including post-traumatic stress disorder.

Limitations

This study had several limitations of note. As mentioned previously, because of the cross-sectional nature of the study, we could not determine causal relationships between concussions and the co-morbid conditions of interest. We were also limited by the lack of generalizability and the selection bias associated with the use of convenience samples. This research attempted to minimize selection bias by utilizing a mandatory general education class that includes students from multiple departments and different academic majors across campus. However, it is important to note that because this sample was gathered from one university, there could be differences in demographic factors between students in our sample and students at other colleges and universities. In addition, our findings might have been impacted by a disproportionately high number of underclassmen and females in our sample.

Another limitation was not assessing if the participant was a member of a collegiate sport team; therefore, the sport-related concussions captured in the measure used could have been experienced by a collegiate athlete (given that collegiate athletes could have been enrolled in the course) or non-athlete. This limits our ability to indicate that the results represent a completely

non-athlete collegiate population. However, the results do provide insight into more of a general college student population, even with the possibility of collegiate athletes being a part of the sample, than the student athlete populations studied previously. In future studies, the collegiate athlete classification should be included as a variable to examine.

There are also several limitations as a result of our assessment of concussions, anxiety, and depression. First, we did not provide any information on the survey to the participants to clarify what is meant by a ‘concussion’. In addition, we did not assess the severity of the concussion, including hospitalizations and the length of time that the participant experienced concussion symptoms. This limits our findings because the severity of the concussion could certainly impact co-morbid conditions. Further, another limitation was not assessing when the participant concussion(s) occurred, as the temporality of the concussion could impact co-morbid conditions. Finally, because we examined anxiety and depression as continuous anxiety symptom and depression symptom variables, the data do not permit an examination of the association of concussion with clinical depression or anxiety.

Conclusions

We found co-morbid relationships between concussions and depression symptoms, anxiety symptoms, and hazardous drinking in our sample of college students. This finding is consistent with the findings in clinical and athlete samples. It is important for college health professionals to be aware that concussion co-morbidity is prevalent in the entire college student population – not just college student athletes.

Disclosures: Both authors (RJM and BHC) report no financial relationships with commercial interests related to the study reported in this manuscript. RJM is a paid consultant for the Division on Addiction Draft Kings research contract.

Ethical approval: This study was approved by the Institutional Review Board at the University this research was conducted.

Informed consent: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

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Table 1. Hazardous drinking scores, depression scores and anxiety scores by concussion status, gender and age among a sample of college students ($N = 1,766$)

	Concussion frequency score (formal and informal diagnoses)	Concussion frequency score (formal diagnoses only)	Hazardous drinking (AUDIT-C sum score)	Depression symptoms (PHQ-9 sum score)	Anxiety symptoms (GAD-7 sum score)
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Sport concussion status					
No concussions ($n = 1,075$)	0.0 (0.0)	0.0 (0.0)	3.0 (2.5)	6.0 (5.7)	6.8 (5.6)
One or more concussions (none sport-related) ($n = 233$)	1.5 (1.0)	0.5 (0.8)	3.3 (2.4)	7.7 (7.0)	8.1 (6.2)
One or more concussion (at least one sport-related) ($n = 458$)	2.9 (2.0)	1.2 (1.2)	4.4 (2.8)	6.5 (6.0)	7.2 (5.8)
Gender					
Male ($n = 680$)	1.2 (1.9)	0.4 (0.9)	4.0 (3.0)	5.2 (5.7)	5.7 (5.4)
Female ($n = 1,086$)	0.8 (1.4)	0.3 (0.8)	3.0 (2.3)	7.1 (6.1)	7.9 (5.8)
Race					
White ($n = 1,223$)	1.1 (1.7)	0.4 (0.9)	3.7 (2.7)	6.2 (5.9)	7.1 (5.8)
Non-White ($n = 543$)	0.6 (1.4)	0.3 (0.7)	2.6 (2.4)	6.6 (6.2)	6.9 (5.7)

Note: AUDIT-C = Alcohol Use Disorders Identification Test-Consumption; PHQ = Patient Health Questionnaire; GAD = Generalized Anxiety Disorder.

Table 2. Regression analyses examining hazardous drinking, depression symptoms and anxiety symptoms by concussion frequency score (formal and informal diagnoses) among a sample of college students ($N = 1,766$)

	Hazardous drinking			Depression symptoms			Anxiety symptoms		
	<i>B</i>	<i>SE</i>	<i>P</i>	<i>B</i>	<i>SE</i>	<i>P</i>	<i>B</i>	<i>SE</i>	<i>P</i>
Constant	5.97	0.28	< .001	2.01	0.67	.003	3.04	0.63	< .001
Gender	-0.94	0.12	< .001	2.02	0.29	< .001	2.39	0.28	< .001
Race	-1.03	0.13	< .001	0.58	0.31	.062	-0.09	0.29	.762
Concussion frequency score (formal and informal diagnoses)	0.30	0.04	< .001	0.32	0.09	< .001	0.28	0.08	.001

Table 3. Regression analyses examining hazardous drinking, depression symptoms and anxiety symptoms by concussion frequency score (formal diagnoses only) among a sample of college students ($N = 1,766$)

	Hazardous drinking			Depression symptoms			Anxiety symptoms		
	<i>B</i>	<i>SE</i>	<i>P</i>	<i>B</i>	<i>SE</i>	<i>P</i>	<i>B</i>	<i>SE</i>	<i>P</i>
Constant	6.34	0.28	< .001	2.50	0.65	< .001	3.52	0.62	< .001
Gender	-1.04	0.12	< .001	1.91	0.29	< .001	2.29	0.28	< .001
Race	-1.09	0.13	< .001	0.49	0.31	.114	-0.18	0.29	.550
Concussion frequency score (formal diagnoses only)	0.39	0.07	< .001	0.30	0.17	.072	0.20	0.16	.214