



Association of physical injury and mental health: Results from the national comorbidity survey- adolescent supplement



Jessica L. Jenness, PhD. ^{a,*}, Cordelie E. Witt, M.D. ^b, D. Alex Quistberg, PhD., M.P.H. ^c, Brian D. Johnston, M.D., M.P.H. ^a, Ali Rowhani-Rahbar, M.D., PhD., M.P.H. ^d, Jessica L. Mackelprang, PhD. ^e, Katie A. McLaughlin, PhD. ^f, Monica S. Vavilala, M.D. ^c, Frederick P. Rivara, M.D., M.P.H. ^a

^a Department of Pediatrics, Harborview Injury Prevention and Research Center, University of Washington, United States

^b Department of Surgery, Harborview Injury Prevention and Research Center, University of Washington, United States

^c Department of Anesthesiology and Pain Medicine, Harborview Injury Prevention and Research Center, University of Washington, United States

^d Department of Epidemiology, Harborview Injury Prevention and Research Center, University of Washington, United States

^e Department of Psychology, Seattle University, United States

^f Department of Psychology, University of Washington, United States

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ABSTRACT

Nonfatal injury is common among adolescents in the U.S., but little is known about the bi-directional associations between injury and mental health. Utilizing a nationally representative sample of U.S. adolescents, we examined 1) associations between lifetime mental health history and subsequent injury; 2) concurrent associations between injury and mental health; and 3) associations between injury and subsequent mental disorders. Data were drawn from the National Comorbidity Survey Replication-Adolescent Supplement (NCS-A), a national survey of adolescents aged 13 through 17 years (N = 10,123). Twelve-month prevalence of nonfatal injury requiring medical attention was assessed along with lifetime, 12-month, and 30-day prevalence of DSM-IV depressive, anxiety, behavior, substance use, and bipolar disorders. We used Poisson regression to examine associations between 1) lifetime history of mental disorders and 12-month exposure to injury; 2) concurrent associations between 12-month exposure to injury and 12-month prevalence of mental disorders; and 3) 12-month exposure to injury and 30-day prevalence of mental disorders. A total of 11.6% of adolescents experienced an injury requiring medical attention in the year before the survey. Lifetime history of mental disorders was not associated with past-year injury. Behavior and bipolar disorders were concurrently associated with past-year injury. Past-year injury occurrence predicted increased risk for past-month anxiety disorders and decreased risk of past-month depressive disorders. Our findings reveal reciprocal associations between injury and mental disorders and highlight the need for systematic assessment, prevention, and treatment of mental disorders among injured youth.

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1. Introduction

Nonfatal injury accounts for 10–16% of all disability worldwide (Haagsma et al., 2016; Murray et al., 2013; World Health Organization, 2010) and is common among children and adolescents (Centers for Disease Control and Prevention (CDC) - National

Center for Injury Prevention and Control, 2014). In 2014 nonfatal injuries in children and adolescents accounted for over 8 million emergency department visits in the U.S. alone, with the highest rates among adolescents across both unintentional (i.e., struck, fall, overexertion) and intentional (i.e., assault) injuries (CDC - National Center for Injury Prevention and Centers for Disease Control and Prevention, 2014). Although substantial research has investigated physical disability outcomes post-injury (World Health Organization, 2013; World Health Organization, 2011), few studies have examined associations between a broad range of injury types and mental disorders in adolescents. The present study

* Corresponding author. Harborview Injury Prevention & Research Center, Box 359960, 325 9th Ave, Seattle, WA, 98104, United States.

E-mail address: jennessj@uw.edu (J.L. Jenness).

aimed to address this gap in the literature by examining the bi-directional associations between nonfatal injury and mental disorders in a nationally representative sample of U.S. adolescents.

Numerous studies have assessed the association between mental health and nonfatal traumatic injury requiring hospitalization in adult samples (Bryant, 2011; Schweininger et al., 2015; Wiseman et al., 2013; Zatzick et al., 2008, 2007). However, adolescents are at heightened risk for injury occurrence relative to children and adults and the majority of adolescent injuries require medical attention *without* the need for hospitalization (CDC - National Center for Injury Prevention and Control, 2014). Prior research examining associations between injury occurrence and youth mental disorders have typically focused on either a specific injury type or cause, such as traumatic brain injury (Mackelprang et al., 2014; Rivara et al., 2012) and motor vehicle crashes (Bryant et al., 2004; Williams et al., 2015), or a specific mental health outcome. Whether injury exposure, regardless of severity, contributes to mental disorder onset or exacerbation among adolescents warrants further attention.

Existing research among children and adolescents suggests that the associations between injury and mental disorders are bi-directional, although little research has examined a wide range of mental health outcomes as predictors and consequences of injury. Behavioral (Brehaut et al., 2003; Davidson, 1987; DiScala et al., 1998; Rowe et al., 2004) and substance use (Cho et al., 2007; Hingson et al., 2000; Mo et al., 2006) disorders are associated with increased risk of injury occurrence among children and adolescents; however, these conditions have infrequently been examined as post-injury outcomes in this age group (Rowe et al., 2007). Anxiety disorders and symptoms have been found to both increase (Rowe et al., 2007) and decrease (Jokela et al., 2009) risk for subsequent injury whereas depressive disorders and symptoms have been associated with increased risk for injury (Asbridge et al., 2014; Patten, 2010; Tiesman et al., 2006). With regard to consequences of injury, elevations in anxiety disorders and symptoms have been shown following injury and motor vehicle crashes (Bryant et al., 2004; Rowe et al., 2007); however, associations between injury occurrence and depressive disorders are inconsistent with some finding an association between injury and depression (Patten, 2010; Zatzick et al., 2006) and others findings no association (Rowe et al., 2007). While associations between injury and bipolar disorder have been rarely studied in adolescents, population-based studies of non-U.S. adults observed strong associations of bipolar disorder with rates of traumatic brain injury (Mortensen et al., 2003; Orlovskaya et al., 2014) and mortality due to both intentional and unintentional injury (Crump et al., 2013). Overall, no studies have investigated the bi-directional associations among a broad spectrum of both mental health disorders and injury exposures in a nationally representative sample of U.S. adolescents.

We examined the association of injury with mental disorders in the National Comorbidity Survey Replication Adolescent Supplement (NCS-A), a nationally representative sample of U.S. adolescents. The NCS-A dataset includes systematic assessments of mental disorder onset and persistence across the lifespan, which we used to understand the reciprocal associations between nonfatal injury and mental disorders. The objectives of this study were to examine: 1) associations between mental health history and subsequent risk for nonfatal injury; 2) concurrent associations between injury and mental health; and 3) associations between injury occurrence and presence of subsequent mental disorders. Given the high degree of diagnostic comorbidity within the NCS-A sample (Kessler et al., 2012b), we examined associations between nonfatal injury occurrence and comorbidity of mental health disorders across these three study aims. Finally, we conducted

sensitivity analyses adjusting for lifetime mental illness across all models examining the associations between injury and concurrent and subsequent risk for mental disorders.

2. Material and methods

2.1. Sample

The NCS-A was based on a national dual-frame household and school sample of adolescents aged 13 through 17 years, and is described in detail elsewhere (Kessler et al., 2009a; Kessler and Merikangas, 2004). Between February 2001 and January 2004, data were collected via in-person interviews with adolescents, and self-administered questionnaires (SAQs) given to one parent or guardian of each adolescent. Written informed adolescent assent was only obtained after consent was given by parents. Both adolescents and parents were paid \$50 for participation. Recruitment and consent procedures were approved by the Human Subjects Committees of Harvard Medical School and the University of Michigan.

The NCS-A household sample included adolescents recruited from households of adults who participated in the National Comorbidity Survey Replication (NCS-R), a survey of adult mental disorders (Kessler and Merikangas, 2004). A total of 879 school-attending adolescents participated in the household survey and an additional 9244 adolescents were recruited from a representative sample of schools in NCS-R sample areas (combined sample = 10,123). Although the proportion of initially selected schools that participated in the NCS-A was low (28.0%), replacement schools were matched to the original schools. No evidence of bias in estimates of either prevalence or correlates of mental disorders was found when household respondents from nonparticipating schools were compared to replacement school respondents (Kessler et al., 2009b). Among adolescent responders, 6483 parents completed the long form SAQ (approximately 1 h to complete).

The current report focused on the 10,123 adolescent responders for the majority of the analyses, including all analyses that examined associations between injury occurrence and depressive, anxiety, substance use, and bipolar disorders. We utilized the 6483 adolescent-parent pairs for whom data were available from both adolescent interviews and long-form SAQ when examining the association between injury and behavior disorders, because parent report has been shown to increase accuracy of behavioral disorder diagnostic classification (Johnston and Murray, 2003). Data from parent SAQs were utilized exclusively for behavior disorder diagnoses in the past 30 days because adolescent-reported behavior disorder data were not available for that timeframe.

Cases were weighted for variation in within-household probability of selection in the household sample. Cases were then weighted separately in the household and school samples for differential nonresponse based on available data about nonrespondents and for residual discrepancies between sample and population sociodemographic and geographic distributions. These weighting procedures are detailed elsewhere (Kessler et al., 2009b). The weighted sociodemographic distributions of the composite sample closely approximate those of the U.S. Census population (Kessler et al., 2009a).

2.2. Measures

Mental Disorders. Adolescents were administered a modified version of the Composite International Diagnostic Interview, a fully structured interview administered by trained lay interviewers that assesses DSM-IV disorders (Kessler et al., 2006; Merikangas et al., 2009). The present study included DSM-IV disorders across five

categories: depressive disorders (major depressive episode, depressive disorder not otherwise specified, dysthymia), anxiety disorders (panic disorder with or without agoraphobia, agoraphobia without panic disorder, social phobia, specific phobia, generalized anxiety disorder, separation anxiety disorder), behavior disorders (attention-deficit/hyperactivity, conduct, and oppositional defiant disorder), substance use disorders (alcohol or drug abuse, alcohol or drug dependence with abuse), and bipolar disorders (bipolar I, bipolar II, bipolar disorder not otherwise specified, hypomania, and mania). Posttraumatic stress disorder (PTSD) was excluded in the main analysis, and instead was examined in a sensitivity analysis, due to our inability to determine whether the diagnosis was a direct result of the injury occurrence. In addition to the five diagnostic categories, we created a continuous diagnostic comorbidity variable by summing the number of diagnoses given across each category with a possible range of 0–5. All diagnoses were made using DSM-IV distress/impairment criteria and organic exclusion rules; diagnostic hierarchy rules were not used.

In order to examine the bi-directional associations between injury occurrence and mental disorders, we created three mental disorder timeframes: lifetime prior to the past 12-months (herein referred to as lifetime), past 12-months, and past 30-days. An algorithm using the lifetime, 12-month, and 30-day diagnosis, age of onset, adolescent's current age, and most recent onset (i.e. recency) variables for each disorder was developed to create the lifetime diagnosis variable that excluded diagnoses with onset during the previous 12-months. Thus, for the purpose of this study, if disorder onset occurred within one year of the adolescent's current age, this was coded as a 12-month diagnosis and not as a lifetime diagnosis. Mental disorders that have diagnostic criteria requiring greater than 30-day symptom duration were defined as present in the past 30-days only if they had durations meeting the minimum DSM-IV requirement.

Physical Injury. We determined exposure to physical injury on the basis of answers to the questions: "In the past 12 months did you have an accident, injury, or poisoning that required medical attention?" and "How many accidents, injuries, or poisonings did you have in the past 12 months that required medical attention?" For the most recent injury, adolescents were asked to endorse any conditions that resulted from their most recent injury from a list of injury types (e.g., sprain, strain; head injury). They were also asked: "Was that a real accident, or was it something you did to yourself on purpose, or something that happened during a fight or attack?" and "Did that occur in the past month or more than one month ago?" In models examining mental disorders present in the past 30-days, we excluded injuries reported to occur in the past month to ensure that injuries occurred prior to 30-day mental disorders.

Sociodemographic Factors. The sociodemographic factors included as covariates were age, race and ethnicity, urbanicity (currently living in metro, other urban or rural areas), poverty index ratio based on family size and the ratio of family income to the family's poverty threshold level, highest level of parent education (less than high school, high school, some college, college graduate), and number of biological parents in the home.

Statistical Analysis. All analyses reported are weighted estimates using the weights provided by in the NCS-A which correspond to the population examined (e.g., behavioral disorders and diagnostic comorbidity analyses were examined only with the parent-adolescent subset). Descriptive analyses were performed to assess associations between reported injuries and sociodemographic factors, as well as between reported injuries and mental health diagnoses. Univariate and multivariable regression was conducted using generalized linear models with a Poisson distribution and log link to estimate risk ratios (RRs) and a robust variance estimator to

obtain 95% confidence intervals (CIs) (Cummings, 2009; McNutt et al., 2003) to assess: 1) lifetime history of mental disorders and 12-month exposure to injury; 2) concurrent associations between 12-month exposure to injury and 12-month prevalence of mental disorders; and 3) 12-month exposure to injury and 30-day prevalence of mental disorders (excluding injuries occurring within 30-days to enhance temporal precision as explained above). We included all sociodemographic variables as covariates in multivariable models. Finally, we conducted the following sensitivity analyses: 1) inclusion of lifetime mental health diagnosis within each diagnostic category (dichotomous yes/no) as an additional covariate when examining associations between injury and 12-month and 30-day mental disorders; 2) restricting analyses to unintentional injuries only to determine whether intentionality significantly alters findings; and 3) inclusion of PTSD in the Anxiety Disorders category. Analysis was performed using Stata version 14 (StataCorp LP, College Station, TX) (StataCorp, 2015). An alpha level of 0.05 was used for statistical significance.

3. Results

3.1. Sociodemographics and injury characteristics

A total of 11.6% of adolescents had an injury requiring medical attention in the year before the survey. Compared to uninjured adolescents, those with history of past-year injury were more likely to be male, older, and white as shown in Table 1. Poverty, urbanicity and family structure were unrelated to injury. Table 2 highlights characteristics of adolescent-reported injuries that occurred within the last 12-months. Most injuries were unintentional (89%), and the most common resulting conditions were musculoskeletal (broken

Table 1
Sociodemographic characteristics and physical injury.

	Injured Weighted % (n = 1131)	Not Injured Weighted % (n = 9011)	P-value
Gender			<0.001
Male	58.5%	50.2%	
Female	41.6%	49.7%	
Age			0.04
13	12.1%	15.7%	
14	20.2%	21.1%	
15	20.3%	20.6%	
16	21.1%	21.0%	
17	20.9%	16.3%	
18	5.4%	5.4%	
Race/Ethnicity			<0.001
Hispanic	9.7%	15.0%	
Black	9.6%	15.8%	
Other	3.8%	5.1%	
White	76.8%	64.1%	
Urbanicity			0.12
Metro	49.6%	47.2%	
Other Urban	37.7%	37.6%	
Rural	12.8%	15.2%	
Poverty Index Ratio (Mean, SD)	6.4 (0.3)	6.4 (0.2)	0.92
Parental education			0.06
Less than high school	13.0%	15.8%	
High school graduate	27.8%	30.0%	
Some college	17.0%	19.8%	
College graduate	42.2%	34.4%	
Caregiver			0.42
Two biological parents	66.6%	69.0%	
Other	33.4%	31.0%	

Note. P-values determined by the adjusted Wald test for difference between categories. Mean Poverty Index Ratio refers to mean percent above or below the poverty line. Weighted percent and unweighted n are presented. Abbreviations: SD = standard deviation.

Table 2
Characteristics of reported injuries among injured adolescents (n = 1131).

	Weighted %
Injury intent	
Unintentional	88.8%
Occurred during fight or attack	3.7%
Did to self on purpose	0.7%
Other or unknown	6.9%
Condition resulting from injury	
Broken or dislocated bones	30.3%
Sprain, strain or pulled muscle	29.3%
Cuts, scrapes or puncture wounds	17.7%
Head injury, concussion	3.4%
Bruise, contusion, or internal bleeding	2.2%
Burn, scald	0.3%
Poisoning from chemicals, medicines or drugs	2.1%
Respiratory problems such as breathing, cough, pneumonia	1.0%
Other or unknown	13.69%
No. of injuries requiring medical attention within the last 12 months	
1	76.6%
2	15.0%
3	4.79%
4	1.70%
≥5	0.6%
Timeframe of most recent injury	
Within the past month	19.3%
Earlier than the past month	80.6%

Note. Reporting injury intent on most recent injury; reporting on the primary condition resulting from most recent injury. Weighted percent and unweighted n are presented.

or dislocated bones; sprain, strain or pulled muscle). Of adolescents with a past-year injury, 77% had only one injury that required medical attention, and 81% of these injuries occurred prior to the past 30-days.

3.2. Lifetime mental disorders and 12-month injury

We evaluated the association between lifetime history of mental disorders prior to the past year and nonfatal injuries occurring in the past year. Univariate analysis showed that adolescents with a lifetime history of depressive (RR = 1.26, CI = 0.97–1.63), behavioral (RR = 1.24, CI = 0.98–1.59), substance (RR = 1.28, CI = 0.97–1.69), or bipolar (RR = 1.35, CI = 0.98–1.59) disorder were at a marginally increased risk of experiencing an injury during the last 12 months (Table 3). After adjustment for covariates, no association was observed of any lifetime mental disorder with past-year injury occurrence. In contrast, we found greater lifetime history of diagnostic comorbidity increased risk for injury occurrence across the past 12-months (RR = 1.10, 95% CI 1.01, 1.19), and this association remained significant adjusting for sociodemographic variables (RR = 1.10, 95% CI 1.00, 1.20) (Supplemental Table 1).

3.3. 12-Month injury and 12-month mental disorders

We assessed the concurrent associations between physical

injuries occurring during the past-year and mental disorders which occurred over the same 12-month timeframe. Univariate analysis showed significant associations between 12-month injury and risk of 12-month substance use disorder (RR = 1.36, 95% CI = 1.04, 1.77), behavioral disorder (RR = 1.26, 95% CI = 1.04, 1.53), and bipolar disorder (RR 1.43, 95% CI = 1.02, 1.99) (Table 4a), and increased risk of diagnostic comorbidity (RR = 1.15, 95% CI = 1.01, 1.30) (Supplemental Table 1). After adjustment for covariates, no significant association was observed of injury with substance use disorders (RR = 1.17, 95% CI = 0.91, 1.52), but the associations of injury with behavior disorders bipolar disorder (Table 4a), and diagnostic comorbidity (Supplemental Table 1) remained significant. All other associations between past-year injury and 12-month mental disorders remained non-significant.

3.4. 12-Month injury and 30-day mental disorders

Next, we examined whether the occurrence of a physical injury in the past year (excluding injuries reported in the last 30-days) was associated with the presence of a mental disorder occurring within the last 30-days. Univariate analysis showed significant associations between injury occurrence and 30-day anxiety disorder (RR = 1.27, 95% CI = 1.03, 1.56) and depressive disorder (RR = 0.53; 95% CI = 0.31, 0.92). There were no significant associations for behavior, substance, or bipolar disorders (Table 4b), or diagnostic comorbidity (Supplemental Table 1). In multivariable analysis, the association between injury in the past year (excluding injury occurrence in the last 30-days) and risk of anxiety disorders and depressive disorders across the last 30-days remained significant. All other associations between injury and mental health disorders remained non-significant (Table 4b).

3.5. Sensitivity analyses

Lifetime Mental Health History. Given possible associations between mental health disorders with both physical injury and occurrence of subsequent mental health conditions, we conducted a sensitivity analysis controlling for the presence of within-category lifetime history of mental disorders in addition to socio-demographic characteristics when predicting presence of 12-month and 30-day mental disorders. The associations of 12-month injury and diagnostic comorbidity (RR = 1.14, 95% CI = 1.05, 1.22) remained significant while associations with 12-month behavior disorders (RR = 1.09, 95% CI = 0.98, 1.20) and 12-month bipolar disorder (RR = 1.16, 95% CI = 0.97, 1.40) were reduced to marginal significance. All other associations between 12-month injury and 12-month mental health disorders remained non-significant. The association between injury in the last 12 months (excluding injury occurrence in the last 30-days) and risk of anxiety disorders in the last 30-days (RR = 1.20, 95% CI = 1.01, 1.42) and risk of 30-day depressive disorder (RR = 0.51, 95% CI = 0.29, 0.90) remained significant. All other associations between 12-month injury and 30-day mental health disorders remained non-

Table 3
Relative risks of adolescent-reported injuries in last 12-months among those with a lifetime history (prior to last 12-months) of mental disorders.

	Depression RR (95% CI)	Anxiety RR (95% CI)	Behavior RR (95% CI)	Substance RR (95% CI)	Bipolar RR (95% CI)
12-Month Injury (Univariate)	1.26 (0.97, 1.63)	1.11 (0.93, 1.34)	1.24 (0.98, 1.59)	1.28 (0.97, 1.69)	1.35 (0.98, 1.59)
12-Month Injury (Multivariable)	1.24 (0.95, 1.61)	1.17 (0.96, 1.41)	1.19 (0.96, 1.48)	1.09 (0.84, 1.43)	1.26 (0.89, 1.78)

Notes. Abbreviations: RR = relative risk, CI = confidence interval. Multivariable analyses include all sociodemographic covariates. Data for lifetime behavioral disorders is derived from both parent and child-reported data.

Table 4

Relative risks of adolescent-reported mental health disorder outcome among adolescents reporting physical injury.

(a)12-Month Injury and 12-Month Mental Disorders				
	Injured 11.6% (n = 1131)	Not injured 88.4% (n = 9011)	Univariate RR (95% CI)	Multivariable RR (95% CI)
Depression	10.2%	9.9%	1.03 (0.80, 1.31)	1.06 (0.82, 1.37)
Anxiety	27.0%	26.3%	1.03 (0.86, 1.23)	1.08 (0.91, 1.30)
Behavior	30.1%	24.5%	1.26 (1.04, 1.53)	1.23 (1.03, 1.46) ^a
Substance	11.1%	8.2%	1.36 (1.04, 1.77)	1.17 (0.91, 1.52)
Bipolar	7.2%	5.0%	1.43 (1.02, 1.99)	1.43 (1.01, 2.02) ^a
(b)12-Month Injury (Excluding Last 30-day Injuries) and 30-day Mental Disorders				
	Injured 9.4% (n = 923)	Not injured 90.6% (n = 9219)	Univariate RR (95% CI)	Multivariable RR (95% CI)
Depression	1.6%	3.1%	0.53 (0.31, 0.92)	0.54 (0.31, 0.95) ^b
Anxiety	19.7%	15.5%	1.27 (1.03, 1.56)	1.38 (1.14, 1.67) ^b
Behavior	14.3%	12.2%	1.18 (0.81, 1.73)	1.13 (0.80, 1.59)
Substance	3.0%	2.6%	1.13 (0.65, 1.96)	0.96 (0.57, 1.61)
Bipolar	2.7%	2.2%	1.22 (0.66, 2.27)	1.20 (0.65, 2.21)

Notes. Abbreviations: RR = relative risk, CI = confidence interval. Weighted percent and unweighted n are presented. Multivariable analyses include all sociodemographic covariates. Data for behavioral disorders within 12-months is derived from both parent and child-reported data while behavioral disorders within 30-days are derived from parent-report only.

^a Remained significant controlling for within category lifetime mental health history.

^b Remained marginally significant controlling for within category lifetime mental health history.

significant.

Injury Intention. While confidence intervals widened due to the decrease in sample size, all of the risk ratio estimates were relatively unchanged when examining only unintentional injuries (Supplemental Table 2).

PTSD Diagnosis. Findings did not significantly differ with inclusion of PTSD in the anxiety disorder category with two exceptions: 1) a lifetime history of anxiety was significantly associated with increased risk of experiencing an injury during the last 12-months once adjusting for sociodemographic characteristics (RR = 1.18, 95% CI 1.01, 1.39) and 2) the association between injury in the last 12-months and risk of anxiety disorders in the last 30-days reduced to marginal significance once adjusting for sociodemographic characteristics and lifetime history of anxiety disorder diagnosis (RR = 1.19, 95% CI 0.99, 1.43) (Supplemental Table 3).

4. Discussion

Although injury is a common occurrence among adolescents, little is known about the interplay between injury and mental health. This is the first study examining associations between injury and a wide range of mental disorders among a nationally representative sample of U.S. adolescents. Nearly 12% of adolescents in our sample reported sustaining an injury in the past year that required medical attention. Although lifetime history of mental disorders did not predict subsequent injury occurrence in the past year, past-year injury was associated with concurrent behavioral and bipolar disorders after adjustment for sociodemographic characteristics. Additionally, injury in the preceding year predicted increased likelihood of anxiety disorders and decreased likelihood of depressive disorder diagnoses in the past month, and these associations remained significant after adjusting for lifetime history of mental disorders. Overall, findings represent an advance in our understanding of the bi-directional associations between adolescent injury and mental health.

We found no evidence for an association between history of mental disorder and likelihood of experiencing an injury among adolescents. This is contrary to some previous investigations, particularly those examining injury risk among youth diagnosed with behavior disorders (Brehaut et al., 2003; DiScala et al., 1998; Rowe et al., 2004). However, the majority of studies examining

risk of injury among youth with behavioral disorders have been cross-sectional. Several longitudinal examinations have found no association of behavior disorders and problems with injury occurrence (Davidson, 1987; Dudani et al., 2010; Rowe et al., 2007). Indeed, a longitudinal population-based study found no association between behavioral problems (i.e., attention-deficit/hyperactivity symptoms and aggression) and injury risk (Dudani et al., 2010), which is consistent with our findings.

Both behavior and bipolar disorders were concurrently associated with the occurrence of injury in the last year. These associations did not persist when limiting our analyses to a past-year injury and subsequent behavior and bipolar disorders in the last month. This pattern suggests the association of injury and behavior and bipolar disorders may be primarily driven by increased risk for injury while experiencing current clinically significant symptoms. Concurrent associations between injury and behavior and bipolar disorders is likely driven by increased impulsivity and risk-taking associated with both behavioral and bipolar disorders (Crone et al., 2016; Reddy et al., 2014), which is consistent with cross-sectional studies showing an association between impulsivity and increased risk for injury occurrence among children (Rowe et al., 2004).

The association between injury occurrence and depressive and anxiety disorders has received less attention in the literature. We found no associations between either lifetime history of anxiety and subsequent injury or concurrent injury occurrence and anxiety disorder diagnosis in the past year. However, a significant association between past-year injury occurrence and anxiety disorder diagnosis in the past month did emerge. This finding is consistent with previous literature demonstrating a cross-sectional association between specific injury types (i.e., poisonings, head injury) and anxiety disorders (Rowe et al., 2004) and longitudinal increases in phobias and separation anxiety symptoms after motor vehicle crashes (Bryant et al., 2004) and unintentional injuries (Rowe et al., 2007), respectively. Indeed, injury occurrence may be considered a particularly impactful stressful life event, and experiences of stressful life events have been strongly associated with prospective anxiety symptom development (McLaughlin and Hatzenbuehler, 2009). Of note, the association between lifetime anxiety disorders and past 12-month injury occurrence became significant once PTSD was included in the analysis, which is consistent with work

showing increased risk taking behaviors among youth following traumatic events (Goenjian et al., 2011; Kmett Danielson et al., 2010). Given differences in the overall pattern of findings with and without the inclusion of PTSD, future research would benefit from prospective studies differentiating associations among specific anxiety disorders and injury occurrence.

Decreased risk of depressive disorders post-injury was an unexpected finding based on previous literature either showing no association between injury occurrence and depressive disorders (Rowe et al., 2007) or an increased risk of depressive disorders post-injury (Patten, 2010; Zatzick et al., 2006). Of note, the association between injury and depressive disorders was not seen in either the lifetime or concurrent analyses and only emerged when examining past-year injury occurrence and presence of depressive disorders in the past month. Given the retrospective nature of the data and lack of specific information regarding injury context, future studies are required to understand the underlying mechanisms of the potential protective association (e.g., post-injury supportive resources or responses) between injury and depressive disorders.

Although we observed a concurrent association between past-year injury occurrence and 12-month substance use disorders in univariate analysis, this association was not significant adjusting for sociodemographic variables. Additionally, there was no association between either history of substance use disorder and subsequent injury nor injury occurrence and later substance use, which have been reported in prior studies of adolescents (Cho et al., 2007; Hingson et al., 2000; Whiteside et al., 2016; Zatzick et al., 2012, 2006). The majority of previous research on post-injury substance use outcomes (i.e., alcohol and opiate use) has examined outcomes of traumatic injury requiring hospitalization. Therefore, the discrepancy in findings may reflect the wider range of injury severity in our sample, which included adolescents whose injuries necessitated medical care, but not necessarily hospitalization.

Due to the high diagnostic comorbidity within the NCS-A sample (Kessler et al., 2012b), we examined associations between injury occurrence and comorbid mental disorders. While we did not find individual categories of lifetime history of mental disorders predicted injury occurrence, we showed a significant association between lifetime history of diagnostic comorbidity and increased risk for injury occurrence across the last 12-months. Furthermore, analyses demonstrated concurrent associations between 12-month injury occurrence and 12-month diagnostic comorbidity. Given the increased functional impairment associated with diagnostic comorbidity (Kessler et al., 2012a; Momartin et al., 2004; Sobanski et al., 2007), it is not surprising to find increased future and concurrent risk for injury among individuals diagnosed with multiple mental disorders. These findings should be replicated in other samples.

This study has several limitations. First, injury occurrence was only measured in the last year, which limits our ability to make firm conclusions about the bi-directional relationship between injury and mental health. Second, while injury rates were commensurate with national rates (CDC - National Center for Injury Prevention and Control, 2014), adolescents may have underreported non-trivial injuries that did not receive medical attention. Third, given the relatively small percentage of youth who experienced an injury in the last year, we were underpowered to examine effect modifiers such as sex and injury mechanism (i.e., motor vehicle crash). While motor vehicle crashes have been shown to be particularly impactful on mental health (e.g., Williams et al., 2015), much of our sample was below the legal driving age (16-years-old). Fourth, due to the lack of precise dates of mental illness onset, we were unable to distinguish between ongoing and new onsets of mental disorders across the last 30-days. Therefore, it is unknown whether injury occurrence relates to 30-day mental health disorder onset or

persistence of a previously existing diagnosis.

This study helps to clarify the link between injury and mental disorders among a nationally representative sample of adolescents. Previous research has typically focused on specific injury types, mechanisms, or severity (i.e., traumatic injury) and circumscribed mental health outcomes while the present study examined a wide range of both injury types and mental disorders. Overall, our findings support the need for a systematic approach to the identification and treatment of mental illness post-injury. Additionally, results suggest the importance of including a wide range of injury types and severity as part of psychological assessment, case conceptualization, and treatment of mental disorders as opposed to a singular focus on traumatic or life-threatening injury requiring hospitalization. Finally, our findings support the need to better understand protective support responses to injury, particularly as a buffer against development of depressive disorders.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.jpsychires.2017.03.022>.

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