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Adolescent Substance Use Following A Deadly U.S. Tornado Outbreak: A Population-Based Study of 2,000 Families

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Abstract

Objective—Despite conceptual links between disaster exposure and substance use, few studies have examined prevalence and risk factors for adolescent substance use and abuse in large, population-based samples affected by a recent natural disaster. We addressed this gap using a novel address-based sampling methodology to interview adolescents and parents who were affected by the fourth deadliest tornado outbreak in U.S. history.

Method—Post-disaster interviews were conducted with 2,000 adolescent-parent dyads living within a 5-mile radius of the Spring 2011 U.S. tornadoes. In addition to descriptive analyses to estimate prevalence, hierarchical linear and logistic regression analyses were used to examine a range of protective and risk factors for substance use and abuse.

Results—Approximately 3% reported substance abuse since the tornado. Greater number of prior traumatic events and older age emerged as consistent risk factors across tobacco and alcohol use and substance abuse since the tornado. Tornado incident characteristics, namely greater loss of services and resources after the tornado and PTSD since the tornado, were associated with greater alcohol consumption. Service loss increased risk for binge drinking, whereas, for substance abuse, PTSD increased risk and parent presence during the tornado decreased risk. Greater family tornado exposure was associated with a greater number of cigarettes smoked in female but not male teen participants.

Conclusions—Both trauma and non-trauma-related factors are relevant to post-disaster substance abuse among adolescents. Future research should examine the role of broader ecological systems in heightening or curtailing substance use risk for adolescents following disaster exposure.

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Keywords

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In the Spring of 2011, 1,706 confirmed tornadoes ravaged the US, resulting in 552 confirmed fatalities (National Oceanic and Atmospheric Administration [NOAA], 2011) and approximately $14 billion in damages (AMBest, 2012). Recovery efforts tend to emphasize rebuilding and healing in impacted communities following such natural disasters. Researchers also have consistently found this post-disaster period to be a time of heightened vulnerability to a range of mental health problems for youth. Posttraumatic Stress Disorder (PTSD), other stress and anxiety disorders, and depression have been commonly examined in young people who have experienced hurricanes, fires, and other natural disasters (Furr, Comer, Edmunds, & Kendall, 2010; Weems & Overstreet, 2008). Although these trauma-related internalizing disorders are prevalent and merit empirical attention (McLaughlin et al., 2013), disasters experienced during adolescence coincide with a developmental period marked with vulnerability to the onset of other mental health problems, including substance abuse (Johnston, O'Malley, Miech, Bachman, & Schulenberg, 2014). Given the high prevalence of disasters (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995) and the cost of substance use problems to public health—estimated at $500B annually in the US (Jason & Ferrari, 2010)—unveiling the prevalence and risk and protective factors for substance use and abuse among disaster-exposed adolescents is critical. Although research has established a link between substance use and trauma exposure in adolescents generally (Giaconia et al., 2000), few studies have examined the prevalence and risk factors of substance use and substance abuse in population-based studies with large samples (versus convenience or purposive samples). Of the handful of studies that have recruited population-based samples of disaster-affected adolescents, none also interviewed parents, and few examined a range of substance use outcomes. Moreover, substance use in youth population-based samples in the aftermath of tornadoes has not been examined. Tornadoes occur more frequently than other disasters and are unique from other disasters (e.g., hurricanes) in that they can strike with little warning and still levy devastating impacts (Evans & Oehler-Stinnett, 2008). Research is needed on how this type of natural disaster can impact adolescent substance use.

Studies that have examined substance use and abuse in disaster-affected adolescents have focused primarily on: 1) accidents and the 9/11 attacks, not natural disasters; 2) prevalence estimates of post-disaster problems, not specific risk and protective factors for those problems; and/or 3) almost exclusively on youth-reported, youth-focused data, not parent-reported or -related variables. The results of these studies have been mixed, with some studies reporting a modest relation between disaster exposure and subsequent substance use, and others reporting a larger effect. Beyond increased prevalence, most of these studies also investigated perceived changes in substance use post-disaster. In a retrospective study, Bolton, O'Ryan, Udwin, Boyle, and Yule (2000) found elevated rates of anxiety and affective disorders, but not substance use disorders, among 216 young people (17-25 years; M=21.3, SD=1.33) who had been teenagers (11-17 years; mean=14.7, SD=1.14) on board a ship (‘Jupiter’) that sank following an accident. The authors reported that 6.5% of the sample misused substances and 4.6% abused substances in the 5-8 years since the marine accident.

In a prospective study, Reijneveld et al. (2003) found evidence of elevated post-disaster substance use problems among adolescents living in a community impacted by a disastrous nightclub fire in Volendam, Netherlands in January 2001. The authors compared substance use data from Volendam adolescents (n=125) prior to the fire (collected for a different study) to substance use problems reported 5 months post-fire (n=91) and in relation to a control sample of adolescents from a different community (pre-fire n=830; post-fire n=643). The authors found clinically significant increases in post-fire excessive alcohol use (74.7%) compared to pre-fire levels (10.3%) among the Volendam adolescents; this increase was more dramatic than in the control group (pre-: 15.1 vs. post: 41.2%). An increase was observed in smoking tobacco as well among the Volendam adolescents (7.2% pre-fire vs. 21.7% post-fire); however, this increase was not statistically different from the increase observed among the control adolescents. In a large sample of NYC high school students (n = 2731) assessed 6-mo following 9/11, Wu and colleagues (2006) found statistically significant support for retrospectively-reported increases in alcohol use among students directly exposed to the attacks. Demographic factors, including older age and white race, were associated with increased risk for drinking in this sample. Similar increases were not found for cigarette use. At an 18-mo post-9/11 assessment in another NYC school sample, Chemtob and colleagues (2009) found evidence of self-reported increases in substance use among middle and high school students (N=1,040). In sum, where substance use has been assessed post-disaster, the majority of studies found support for a significant association between disaster exposure and substance use, particularly alcohol.

To date, two studies have examined specific risk factors for substance use problems in a natural disaster sample. Rohrbach and colleagues (2009) examined predictors of changes in substance use among a hurricane-exposed sample of high school students who had recently participated in a drug abuse prevention trial (n=280). Exposure to the hurricane, which was relatively low among the sample, and post-hurricane negative life events predicted increases in substance use. Although it is a strength that pre-hurricane substance use data were collected, it is unknown the degree to which the drug abuse prevention intervention (delivered prior to the hurricane) impacted changes in substance use over this time period. In addition, as parental exposure to disasters has been found to predict negative child outcomes (Pfefferbaum et al., 2013), the sole focus on youth report of exposure may limit the full scope of what can be learned about post-disaster substance use from this sample. In another study, Rowe and colleagues (2010) assessed individual (hurricane-related characteristics, history of substance abuse, traumatic event (TE) history, post disaster delinquency) and familial factors (parental substance abuse history, post-disaster parental psychopathology, family cohesion, parental monitoring) among adolescents (N=80, 13-17 years) and their caregivers who had experienced Hurricane Katrina in the past 16-46 months and presented for substance abuse treatment. Higher family income, adolescent-reported lower parental monitoring, and post-disaster delinquency were significant risk factors for adolescent substance use. Although trauma-related factors were related to PTSD symptoms, these variables were not significantly associated with substance use. This study provides an important foundation for understanding post-disaster adolescent substance abuse, but the exclusive focus on a clinic-referred, predominantly male sample (87%) and a substantial time frame since the Hurricane (16-46 months later) limit generalizability of the results to

questions about what factors may be targeted via screening and early intervention efforts in a post-disaster context to identify subclinical levels of substance use problems in a community sample of adolescents.

Thus, several unanswered questions remain regarding substance use among adolescents in the context of disasters. Despite the lacking association between trauma-related factors and substance use in the aforementioned clinical sample (Rowe et al., 2010), other prior studies investigating the relation between traumatic stress and substance use (Blumenthal et al., 2008; Danielson et al., 2009), and the theoretical models guiding these prior studies, suggest the possibility of a clinically meaningful association between these factors. The most common theoretical model linking TEs to substance abuse is the negative reinforcement model, which suggests an individual uses substances to decrease negative affect he or she experiences as a result of the trauma ("self-medication hypothesis"). For example, an adolescent who experiences a tornado and significant distress from that experience (e.g., PTSD) may be more likely to drink alcohol as a form of coping with distress. There is some support for the self-medication model in the extant literature. For example, in the National Survey of Adolescents (NSA), current PTSD predicted substance abuse in an epidemiological sample of adolescents (Kilpatrick et al., 2000). Similarly, numerous studies support cumulative stress models, where TE history and greater TE exposure are associated with worse mental health outcomes (e.g., MacDonald, Danielson, Resnick, Saunders, & Kilpatrick, 2010), perhaps due to trauma's "wear and tear" on the body (allostatic load). Per cumulative stress models, we would expect adolescents who experienced TEs in childhood prior to the tornado might be more likely to engage in post-disaster substance use. The degree to which TE history and PTSD, as well as the family's disaster exposure, are associated with substance use and abuse in natural disaster-exposed adolescents has not been examined. Further, these factors have not been investigated in the context of interactions with other potential risks for substance use (e.g., age, gender).

Weems & Overstreet (2008) have proposed a developmentally-informed ecological needs-based perspective, suggesting disasters may impact development and mental health by interfering with basic needs, goals, and adjustment following a TE. Rooted in Bronfenbrenner's ecological systems theory (Bronfenbrenner, 1979), the model posits that the multiple, interacting contexts (microsystem, macrosystem, exosystem) in which a youth resides following a disaster drive adaptation. Aspects of these ecologies can either foster resilience or confer vulnerability to problematic outcomes following a disaster. While no studies have directly applied or tested this model with regard to post-disaster substance use in youth, research with students in NYC 6 months following the 9/11 attacks supported this ecologically-based model in the association between disaster-related daily life disruptions and youth internalizing problems. Specifically, Comer and colleagues (2010) found that various disruptions to family members (e.g., job loss, restricted travel) reported by 8,236 youth in grades 4-12 were associated with probable PTSD, anxiety disorders, and depression. This perspective emphasizes the importance of consideration of disaster-related factors (e.g., loss of job, services) beyond the immediate aftermath of a disaster. Further, the ecological needs-based perspective calls for inclusion of family-related variables that may impact parenting behaviors and the home environment (parental distress, family history of substance use) (Hawkins et al., 1992; Kilpatrick et al., 2000).

We sought to extend the natural disaster-adolescent substance use literature by assessing cigarette use, alcohol use, and substance abuse, and risk and protective factors, informed by the studies reviewed above, among a sample of 2,000 adolescents living in communities affected by the Spring 2011 tornado outbreak. Our aims were to: 1) report prevalence estimates of tobacco use, alcohol use, and substance abuse among these adolescents; and 2) identify risk and protective factors for substance use and abuse in the past-month (current) and since the tornado. We hypothesized that demographic, TE history, PTSD since the tornado, tornado incident characteristics, and parental factors (perceived history of substance abuse, parental distress) would confer risk for post-disaster substance use and abuse. We also examined substance use and abuse resulting from interactions between family tornado exposure and other common predictors (e.g., demographics, prior traumatic experiences) in secondary analyses.

Method

Sampling Frame and Procedure

Two thousand families with adolescents were recruited from areas affected by highly damaging tornadoes that touched down on April 25-28 or May 22, 2011. On April 27, 2011, northern Alabama experienced 39 tornadoes ranging from Enhanced Fujita (EF) scale categories 4 (winds 166-200 mph) to EF 5 (winds greater than 200mph). Over 14,000 homes were deemed uninhabitable, 2,200 people were injured, and 240 individuals were killed (Addy & Ijaz, 2011; NOAA, 2012; Wind Science and Engineering Center, 2004). On May 22, 2011, an EF 5 tornado struck the city of Joplin, MO, leaving more than 7,000 homes destroyed, over 1,000 injured, and 150 dead (NOAA, 2011). A highly targeted address-based sampling strategy was used to recruit families into the study. Tornado track latitude/longitude coordinates obtained from NOAA (2011) incident reports were used to define the sampling frame. The distances of the radii surrounding the latitude/longitude coordinates (5 miles for EF-4/EF-5; 2 miles for EF-2/EF-3) ensured a high percentage of households were recruited from neighborhoods directly affected by the storms, which was intentional as the current investigation was conducted as part of a larger study focused on web-based post-disaster early intervention. Thus, families living in households in close geographic proximity to the paths of these tornadoes were considered most likely to benefit from widely accessible mental health resources. A two-stage process was used to recruit eligible families. First, we identified households in the designated sampling regions with a landline telephone match in public listings. Second, household addresses without a landline telephone match (mostly cell-phone-only households) were sent a letter describing the study and an eligibility screen. This approach allowed necessary precision in defining the sampling frame due to the localized nature of tornadoes, as well as recruitment of cell-phone-only households. The final sample included families from Alabama (73%) or Missouri (17%) and surrounding states (10% MS, TN, GA).

Families that returned the screen received $5 regardless of eligibility. The survey research firm, Abt SRBI, contacted households in the landline-matched and mail-screen samples to assess and confirm study eligibility. Caregivers identified as legal guardians of an adolescent aged 12-17 years, and their adolescents, were eligible to participate if they resided in their

address at the time of the tornado and had reliable home Internet access, as the current assessment was the baseline assessment for an Internet-based intervention study. The Internet access criterion had minimal impact on recruitment, and data from the Pew Internet and American Life Project indicate 95% of adolescents use the internet and 93% have household access to computers (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013). The overall cooperation rate, calculated according to the American Association for Public Opinion Research industry standards (i.e., [number screened] divided by [number screened + screen-outs + unknown eligibility]), was 61%. After a description of the study, verbal informed consent was obtained from parents and adolescents. Eligible dyads completed a structured telephone interview between September 2011 and June 2012, on average 8.8 months after the tornado [*SD*=2.6; range=4.0-13.5]. Households that completed the interview were mailed $15. The study was conducted in compliance with policies and procedures of the IRB at the authors' institution.

Participants

Demographic characteristics of the sample, which were assessed during the parent interview, are summarized in Table 1. Data were weighted to enhance the generalizability of the sample to the larger population of the communities from which they were recruited.

Measures

Family tornado exposure and impact variables—Caregivers were asked whether they were present when the tornado hit, if they sustained any physical injuries, if they were concerned about the safety or whereabouts of loved ones, or if the family was displaced from their home for more than a week. These items have been used in prior studies on the mental health impacts of natural disasters (e.g., Acierno et al., 2007; Ruggiero et al., 2012). Time since tornado was defined as the amount of time in months between the date of the tornado that affected each participant's community and the date each participant completed the assessment. Each of these impact characteristics was entered individually as predictors in analyses. Descriptive statistics are provided in Table 1.

Property damage—Caregivers also were asked questions about damage caused by the tornado to their homes, vehicles, furniture, personal items, and pets. A property damage scale representing a count of how many different types of property damage were incurred was used as a predictor in the analysis (Cronbach's alpha = .75).

Loss of services—Caregivers were asked whether they were without basic services for a period of greater than one week, including water, electricity, clean clothing, food, shelter, transportation, and spending money. A loss of services scale representing a count of how many basic services were lost was used as a predictor in the analysis (Cronbach's alpha = . 67).

Prior exposure to natural disasters—Adolescents were asked whether they had ever experienced a prior natural disaster. Responses were dichotomized (1=yes, 0=no).

Other potentially traumatic experiences (PTEs)—Adolescents were asked whether they had ever experienced each of five PTE types including physical assault, physical abuse, witnessed domestic violence, witnessed community violence, and serious accidents. Behaviorally specific prompts were used for each PTE type, consistent with questions used in the National Survey of Adolescents (NSA; Kilpatrick et al., 2000). A count of endorsed prior PTE types was used as an index of prior trauma history severity.

PTSD—PTSD was assessed using the PTSD module used in the NSA and other large-scale epidemiologic surveys conducted by this team (e.g., Kilpatrick et al., 2003). This structured interview assesses each of the DSM-IV (APA, 2000) symptom criteria for PTSD. Participants were specifically asked if these symptoms were present since the tornado or before the tornado—but were not asked explicitly if the symptoms were a result of the tornado. Participants were coded as positive for PTSD if they met criteria during the time period since the tornado. Reliability and concurrent validity of this measure have been established (Kilpatrick et al. 2003).

Perceived Family History of Substance Abuse—This was assessed by asking adolescents if anyone in their family, not including themselves, has spent so much time drinking alcohol or using drugs that it became a problem.

Tobacco Use—Tobacco use was assessed by asking adolescents whether they had 1) ever tried smoking cigarettes, 2) smoked cigarettes daily for 1+ months, and 3) smoked 1+ days in the past month. Adolescents also indicated the number of cigarettes smoked in the past month.

Alcohol Use and Binge Drinking—Past-year alcohol use was assessed by asking whether adolescents drank beer, wine, liquor, or any other alcoholic beverage every day, some days or not at all during the past 12 months. Adolescent past-year binge drinking—a strong predictor of adult alcohol use problems (Chassin, Pitts, & Prost, 2002) and other health risk behaviors (Miller, Naimi, Brewer, & Jones, 2007) --was assessed with the NIAAA standards of heavy drinking. Adolescents indicated whether they drank 4 or more drinks (for females) or 5 or more drinks (for males) in one day in the past-year. Past-month alcohol use was based on adolescents' reports of the number of drinking days in the past month and the number of drinks per drinking day. This information was also used to determine whether participants engaged in binge drinking in the past-month based on the above criteria.

Substance Abuse—Adolescent substance abuse was assessed using the CRAFFT (Knight, Sherritt, Harris, Gates, & Chang, 2003), a well-established, standardized, 6-item self-report measure designed specifically for adolescents. Respondents completed six dichotomous questions about engagement in risky substance use behaviors (e.g., "Did you ever use drugs or substance when you were by yourself?"). The CRAFFT was used to assess potential substance abuse in the adolescent's lifetime, since the tornado, and during the past month. The scale has good internal consistency and validity (Knight et al., 2003). Consistent with prior research (Knight et al., 2003), we classified participants as meeting criteria for probable substance abuse if they endorsed two or more items. In the context of a large-scale

disaster, there is also need to identify adolescents who endorse subclinical levels of substance abuse and may benefit from early intervention services. Therefore, we also examined prevalence estimates and risk and protective factors for substance abuse with a CRAFFT score of 1 or more.

Results

Data Analysis

Prevalence data and descriptive statistics are presented for historical and current (past-month or since the tornado) substance use and abuse. Correlations were computed among the substance use and abuse variables and a variable representing the amount of time that transpired between the tornado and the baseline assessment ('time since tornado'). Hierarchical linear regression and logistic regression were used to investigate risk and protective factors for each outcome. Predictors were entered in four steps: (1) demographics, (2) family factors, (3) prior trauma history, and (4) family tornado exposure characteristics, which included time since tornado. An alpha level of .05 was set *a priori*.

As secondary analyses, we tested examined whether family tornado exposure moderated the association between predictor variables with the various substance use outcomes. We examined whether a composite measure of overall family tornado exposure (described below) interacted with gender, age, White/Non-White race/ethnicity, number of prior traumas, and time since the tornado to predict the different substance use outcomes (cigarettes smoked in the past month; alcoholic drinks consumed in the past month; binge drinking in the past month; substance abuse based on the 2+ CRAFFT threshold). The composite measure of family tornado exposure ('composite exposure') is a sum of the 17 disaster exposure and impact, property damage, and loss of services variables (described below, each coded as present or absent). The measure has good internal consistency (alpha = .81), and has been used in prior research with this sample (Paul et al., in press). This measure ranged from 0 to 17, with a mean of 5.07 (SD=3.19) in our sample.

In these models, we included the main effects of the variables in the interaction (both coded as Z-scores [if continuous] or as 0 or 1 [if dichotomous] as well as an interaction term (computed by multiplying the Z-score for the composite exposure variable with the Z-score or dichotomous variable for the other variable in the interaction; c.f., Cohen, Cohen, West, & Aiken, 2003). We followed up any significant interactions with tests of simple main effects.

Associations Among Substance Use and Abuse Variables and Time Since Disaster

There was not a consistent pattern of associations found between time from tornado to baseline and the substance use and abuse variables, with correlations ranging from −0.06 (number of cigarettes smoked in the past month) to .04 (positive CRAFFT screen for substance abuse based on the 1+ threshold). Only one correlation (for cigarette smoking) was statistically significant (r=−0.06, p=.02), suggesting a negative relation between the variables. Youth who had less amount of time between the tornado and baseline assessment were more likely to report smoking a greater number of cigarettes.

Prevalence of Substance Use

Prevalence estimates and descriptive statistics for all substance use and abuse variables are presented in Table 2. One gender difference emerged. Males reported a higher rate of lifetime smoking experimentation (15.6%) than females (11.8%), $\chi^2(1, n = 1998) = 6.19$, $p = .01$. This finding was driven primarily by adolescents aged 16- and 17-years: in that age group, 27.7% of males endorsed a history of trying cigarettes versus 19.7% of females, $\chi^2(1, n = 689) = 6.15$, $p = .01$. Older adolescents consistently exhibited higher rates of tobacco and alcohol use and were more likely to screen positively for substance abuse on the CRAFFT than younger adolescents.

Risk and Protective Factors for Post-Tornado Substance Use

Results of hierarchical linear and logistic regression analyses predicting tobacco use, alcohol use, and substance abuse since the tornado are presented in Tables 3 and 4. Results for subclinical substance abuse (endorsing 1 or more items on the CRAFFT) are presented in text only below. In the final multivariable linear regression predicting current tobacco use, demographic variables significantly and uniquely associated with the number of cigarettes smoked in the past month included older age ($\beta = 0.13$, $t = 4.71$, $p < .0001$) and Other Race (vs. Caucasian) ($\beta = 0.07$, $t = 2.54$, $p < .05$) as risk factors, whereas African-American (vs. Caucasian) ethnicity was a protective factor ($\beta = -0.09$, $t = -2.86$, $p < .01$). A perceived family history of substance use problems was associated with a greater number of cigarettes smoked in the past month (β=0.10, t = 3.52, $p < .0001$). Variables related to TE history (Step 3 in the regression) added predictive value to past-month cigarette smoking (F Change (2, 1316) = 14.14, p < .0001, R^2 change = .02) beyond demographic variables (Step 1) and family-related variables (Step 2). Specifically, prior natural disaster exposure was a protective factor associated with less past-month cigarette smoking ($\beta = -0.07$, $t = -2.01$, $p < .05$), whereas exposure to a greater number of PTEs was associated with greater past-month cigarette smoking ($\beta = 0.17$, $t = 5.07$, $p < .0001$). Time since the tornado was the only tornado-related characteristic (Step 4) that served as a risk factor for past month cigarette use ($\beta = -0.06$, $t = -5.07$, $p < .05$), with less time related to greater cigarette use; however, this fourth overall step in the regression was not significant (F Change (8, 1308) = 1.26, p = .26, R^2 change = .007).

Older age ($\beta = 0.10$, $t = 3.95$, $p < .0001$), a perceived family history of substance use problems ($\beta = 0.07$, $t = 2.73$, $p < .01$), and exposure to a greater number of PTEs ($\beta = 0.10$, $t = 3.06$, $p < .01$) were associated with a greater number of alcoholic drinks consumed in the past-month, as were several family tornado exposure characteristics: less property damage from the tornado ($\beta = -0.07$, $t = -2.08$, $p < .05$), greater loss of services and resources from the tornado ($\beta = 0.07$, $t = 2.26$, $p < .01$), and a diagnosis of PTSD since the tornado ($\beta = 0.08$, , $t = 2.96$, $p < .01$). African-American ethnicity was a protective factor associated with fewer alcoholic drinks consumed (β=−0.06, $t = -2.04$, $p < .05$). Significant predictors of current binge drinking in the final multivariate logistic regression included older age (OR=2.49), perceived family history of substance abuse (OR=3.60), history of exposure to a greater number of PTEs (OR=1.84), and greater loss of services from the tornado (OR=1.82). African-American ethnicity was found to be a protective factor (OR=0.14).

In the final multivariable model for substance abuse, older age (OR=1.44), a perceived family history of substance use problems (OR=4.52), a history of exposure to a greater number of PTEs (OR=2.17), and PTSD since the tornado (OR=2.50) emerged as risk factors. Having a parent who was present for the tornado (OR=0.27) was a significant protective factor with respect to substance abuse since the tornado. When examining subclinical substance abuse since the tornado, older age (OR=1.35), perceived family history of substance abuse (OR=2.65), number of PTEs (OR=1.83), and PTSD diagnosis since the tornado (OR=1.97) emerged as risk factors in the final model, whereas prior natural disaster experience (OR=0.65) and having a parent present for the tornado (OR=0.43) were protective factors (p's<.05).

Potential Moderating Effects of Composite Family Tornado Exposure with Post-Tornado Substance Use

Of the interaction models tested, only two were significant. First, the interaction of gender by composite exposure predicted the number of cigarettes smoked in the past month. Data were then stratified by gender and the association between the composite exposure variable with cigarette smoking was examined separately in male (n=877) and female participants (n=877). Greater family tornado exposure was significantly associated with a greater number of cigarettes smoked in female participants (b = 4.46, SE = 1.17, 95% CI [2.16, 6.76], β = 0.13, t = 3.81, p < .0001). However, the association between composite exposure and cigarette smoking was not statistically significant in male participants (b = 0.15, SE = 1.45, 95% CI [−2.70, 3.00], β = 0.004, t = 0.10, p = .92).

Second, the interaction of age and family tornado exposure in predicting number of cigarettes smoked was significant. The simple main effects of the composite exposure variable on cigarette smoking was examined for the mean age in the sample, as well as 1 SD above and below the mean, by re-centering the Z-score age variable so that a value of zero corresponded to 1 SD above and below the mean. The association between family tornado exposure and cigarette smoking was not significant for participants aged 1 SD below the mean (b = −0.41, SE = 1.27, 95% CI [−2.90, 2.07], β = −0.01, t = −0.33, p = .74). For participants aged 1 SD above the mean, greater family tornado exposure was significantly associated with a greater number of cigarettes smoked (b = 5.50, SE = 1.34, 95% CI [2.87, 8.13], β = 0.14, t = 4.10, p < .0001). The association between composite exposure with number of cigarettes smoked was positive and significant for participants with the mean age as well, although the effect size was smaller compared to the 1 SD above the mean group (b = 2.54, SE = 0.92, 95% CI [0.73, 4.35], β = 0.07, t = 2.76, p = .01). In other words, greater family tornado exposure was associated with a greater number of cigarettes smoked with increasing age, with the largest associations observed for the oldest participants. No interactions were significant for alcohol use, binge drinking, or substance abuse.

Discussion

Few studies have examined substance use and abuse among disaster-exposed adolescents. Results to date suggest the need for a better understanding of the problem (La Greca, 2007), particularly in large, population-based community samples that more closely resemble the

milieu encountered by health workers in a post-disaster context than clinic-based settings. The current study is the first to provide empirical information regarding patterns of substance use among adolescents impacted by the Spring 2011 tornadoes, as well as individual-, family-, and trauma-related factors associated with risk for substance use and abuse in this population. Such information carries important implications for testing theoretical models linking disaster exposure to post-disaster adjustment (e.g., Weems & Overstreet, 2008)—including substance use and abuse—as well as for community-based screening and early intervention services for adolescents at risk for substance abuse in the aftermath of a disaster (Chemtob et al., 2009).

The first aim of this study was to report prevalence of several substance-related outcomes in adolescents exposed to the Spring 2011 tornadoes. In general, estimates of substance use in this sample were lower than national averages. For example, in the 2013 Monitoring the Future (MTF; Johnston et al., 2014) survey, lifetime cigarette use ranged from 14.8% among eighth graders to 38.1% among twelfth graders, whereas lifetime cigarette use in this sample was 13.3% for 14-15 year olds and 23.2% for 16-17 year olds. Past-month cigarette use was similarly low (non-existent among the 12-13 year-olds and peaking at 8.1% among 16-17 year-old male adolescents). A similar pattern was observed for alcohol use. Alcohol use in the past-year was higher among older youth in this sample (1.5% of 12-13 year olds, 6.7% of 14-15 year olds, and 17% of 16-17 year olds), but fell below past-year alcohol use estimates from the MTF 2013 survey, which ranged from 22.1% of eighth graders to 62% of twelfth graders. One possible explanation for the relatively low base rates observed in this study is that regional or community-level factors not measured here (e.g., cultural norms, laws related to access) may have contributed to lower levels of substance use among adolescents in the communities from which participants were recruited. Whereas some studies have found evidence of increases in substance use among adolescents following disasters (Rohrbach, Grana, Vernberg, Sussman, & Sun, 2009), other studies have found no change (Bolton et al., 2000), or even decreases in post-disaster externalizing problems (Stuber et al., 2005). Unfortunately, we did not have pre-disaster substance use data from this particular sample of adolescent and, thus, were unable to determine if cigarette or alcohol use was impacted among the participants following the tornadoes.

We examined substance abuse since the tornado in two ways in the current sample: 1) with a conventional score of 2 or more on the CRAFFT, which yielded a prevalence estimate of 3.2%; and 2) with a less conservative score of 1 or more on the CRAFFT, which yielded an estimate of 11.3%. Epidemiological research suggests substance abuse prevalence estimates fall in the middle of this range at approximately 7% of the general adolescent population (Kilpatrick et al., 2000). Importantly, adolescent endorsement of any one of the CRAFFT items could be functionally impairing (e.g., family or friends say you should cut down; getting in trouble as a result of your substance use) and informative when screening for youth who are potential candidates for substance use risk reduction programs (Hawkins, Catalano, & Arthur, 2002). Despite the somewhat lower prevalence of substance abuse in this sample compared to national averages, it is important to note that it was still present and should be incorporated into post-disaster mental health screening. For instance, more than 1 in 6 adolescents aged 16-17 endorsed at least one harmful substance use behavior per the CRAFFT in the time period since the tornado.

The second aim of the study was to identify predictors of substance use and abuse among disaster-affected adolescents, followed by secondary examinations of potential moderating effects of these predictors with family tornado exposure on the cigarette, alcohol, and abuse variables. Despite low overall prevalence of use, significant associations between empirically- and theory-guided predictors and substance use outcomes were observed. For example, consistent with prior research (Ellickson, Martino, & Collins, 2004), older age was associated with higher prevalence of cigarette use, whereas being African-American was protective against cigarette use. Prior trauma was relevant to cigarette use in this population, in that prior the number of previous PTEs conferred risk for current cigarette use. This latter finding is consistent with other population-based community samples, where prior victimization history was linked to cigarette use in both boys and girls (Acierno et al., 2000). Interestingly, cigarette use was the only variable for which the amount of time between the tornado and baseline assessment and the overall composite of family tornado exposure was potentially relevant. Time since tornado resulted in a significant negative correlation with smoking, as well as a significant predictor variable in the regression. Although the step that included specific tornado-related factors did not significantly improve the overall prediction model when accounting for other factors (e.g., demographics, trauma history), the interaction analyses suggest that perhaps, for girls and for older adolescents, the degree of tornado impact may contribute to smoking. Considered together and within the theoretical framework proposed by Weems and Overstreet (2008), as well as post-disaster adjustment research by Comer et al. (2010), these findings also highlight the importance of further considerations and investigations of how post tornado-related disruptions, including duration of these disruptions, may have differential impacts by gender and across development.

As with cigarette use, age, perceived family history of substance abuse, and prior PTE exposure were associated with past-month alcohol use. In contrast to past-month cigarette use, specific tornado-related factors—loss of services and resources due to the tornado and PTSD since the tornado—were particularly relevant to past-month alcohol use. The latter finding is consistent with prior research (Schroeder & Polusny, 2004), supporting the notion that adolescents may use alcohol to cope with trauma-related distress in the aftermath of a disaster. Interestingly, tornado-related property damage emerged as a protective factor against the number of alcoholic drinks consumed. It is possible that increased property damage led to bolstered protective factors for adolescent alcohol use (e.g., increased parental monitoring as a result of parent being present at home to attend to the damaged areas), or perhaps, impacted access to alcohol. The pattern of risk and protective factors for past-month binge drinking among these adolescents was not identical to the pattern for past-month alcohol use. Adolescents whose caregivers reported greater loss of services and resources were almost twice as likely to report binge drinking than those without service loss. Within the ecological-needs framework, loss of services can impact communities and families at many levels, such as temporary job losses and extensive time and effort in working with over-burdened insurance companies and contractors (exosystem). This can lead to ‘ripple effects’ (Comer et al., 2010) that may impact access to alcohol (e.g., parental attention focused on restoration of services). With regard to microsystem influences, prior PTE exposure also emerged as a significant risk factor for binge drinking. This is consistent with the cumulative stress models (MacDonald et al., 2010) and call for the need for

continued efforts in better understanding the pathways between stress and substance use problems across the lifespan.

As such, the fact that tobacco and alcohol use were not comparably predicted by tornado-related factors suggests that there are different pathways to substance use in a disaster-exposed adolescent sample that vary by substance. These differential findings could be related to varying pharmacological effects, such as smoking to 'calm nerves' or relieve acute distress, whereas binge drinking could be in service of emotional numbing or of enhancing positive emotions. That is, viewed through a negative reinforcement lens, selection of which substance a youth uses to cope might be dictated by the type of distress the youth is trying to cope with and the desired effects. Other possibilities, such as social acceptability of one type of substance versus another within a household, and variable addiction risk, also may contribute to differential results based on substance type. Unfortunately, the low base rates and the necessarily brief assessment battery in the current study limited our capacity to tease apart all the pathways potentially represented in the sample. Future studies should focus on more explicitly testing potential pathways, including the nuances of how post disaster-related disruptions lead to specific substance use and misuse.

Regardless of which approach and cut score was applied (i.e., 1+ vs. 2+ on the CRAFFT), multiple disaster-related variables were associated with substance abuse in this sample. Having a parent present during the tornado was a protective factor for post-tornado substance abuse. Inherent to an event being defined as 'traumatic' is the fear that you or someone else you care about will be hurt or killed during that event. Perhaps adolescents who knew their parents were safe, because they were with them during the tornado, were less likely to experience the tornado as traumatic—and hence be at decreased risk for post-tornado negative sequelae, including substance abuse. This may be particularly relevant for disaster-exposed youth with poor coping, who may have a greater likelihood of using substances to self-medicate when experiencing distress. Alternatively, loss of basic services and resources from the tornado emerged as a risk factor for alcohol use. As noted above, loss of basic services, such as water and electricity, likely results in the need for parents to spend time and energy attending to these basic needs for the family—and perhaps results in diminished parental monitoring. Indeed, Rowe and colleagues (2010) found that lower parental monitoring was one of the strongest predictors of adolescent substance use following Hurricane Katrina. Although we did not measure parental monitoring directly in the study, Weems and Overstreet's model (2008) suggests that loss of basic services and resources from disasters may create disruptions in many contexts (school closings, parent's workplace, communication systems)—which could ultimately impact the degree to which a youth using alcohol falls 'below the radar' (of parents, teachers, etc.).

A noteworthy strength of this study was the use of a highly targeted address-based sampling approach to recruitment and data collection, which yielded a diverse sample (~30% ethnic/racial minority) representative of the target communities. One of the major limitations noted among prior post-disaster research with youth has been the over-reliance on convenience sampling (e.g., school- or clinic-based), which typically omits data collection from caregivers and limits generalizability of the findings (Furr et al., 2010). However, address-based sampling approaches are highly costly, and difficult decisions must be made in

administering an assessment that balances cost with breadth and depth of data collected. Several limitations of the study extend from these difficult decisions and cost-related constraints. First, specific substance use focused solely on two commonly used substances—cigarettes and alcohol—and did not permit assessment of other substances or diagnostic interviewing for DSM-defined substance use disorders. The use of the CRAFFT afforded the capture of potential substance misuse; however, unanswered questions remain regarding prevalence estimates for specific drugs. In addition, substance use assessment was limited to self-report. Although adolescents have been shown to be valid reporters (Winters, Stinchfield, Henly, & Schwartz, 1990) and steps were taken to increase the likelihood of adolescents' privacy during the interview, under-reporting is always a possibility. Similarly, costs precluded the collection of multi-informant data regarding disaster-related impact (e.g., child direct exposure may not have been fully captured). Also, due to the way in which PTSD symptoms were assessed, we were unable to determine whether symptoms were specifically related to the tornado or other PTEs. Another limitation is that these findings are based on cross-sectional assessment, in the absence of pre-tornado substance use data or data from a matched, non-tornado exposed control group. These latter limitations prohibit our ability to determine if the tornado has a causal role in post-disaster adolescent substance use. Prospective research is challenging in natural disaster research as it is not possible to predict in sufficient time when and where such a phenomenon is going to hit. One approach to consider in attempting assessment of pre-disaster substance use and overall functioning is periodic surveillance surveys in disaster-prone communities (e.g., Tornado Alley). Future directions for this line of research also should involve more thorough and longitudinal assessments of post-disaster trajectories for substance use and incorporate the measurement and consideration of ecological influences as outlined by Weems and Overstreet (2008).

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Table 1

Demographic and disaster-related factors among the adolescent sample (N = 2,000)

Characteristic	%	Mean (*SD*)
Gender (Female)	50.9	
Age		14.5 (1.7)
Race (White/Caucasian)	70.5	
Black/African-American	25.6	
Other	3.9	
Household annual income <$20,000	24.0	
Prior natural disaster	26.9	
Prior traumatic events		1.0 (1.1)*
Time since tornado (months)		8.8 (2.6)
Present during tornado	90.6	
Physical injury	2.7	
Concerned about safety of loved ones	74.8	
Displacement (>1 week)	9.0	
Property damage		1.4 (1.6)**
Loss of services		0.6 (1.1)**

Note.

* Possible Range: 0-5.

** Possible Range: 0-7.

Table 2

Prevalence Estimates and Descriptive Statistics for Adolescent Tobacco Use, Alcohol Use, and SA

	Overall			12-13 years old			14-15 years old			16-17 years old		
	Total	Females	Males	Total	Females	Males	Total	Females	Males	Total	Females	Males
Lifetime Tobacco Use												
Tried smoking cigarettes	*N* = 1998 13.7%	*n* = 1018 11.8%[a]	*n* = 980 15.6%[b]	*n* = 661 4.2%[c]	*n* = 322 3.1%	*n* = 338 5.3%	*n* = 645 13.3%[d]	*n* = 306 11.1%	*n* = 339 15.3%	*n* = 689 23.2%[e]	n = 386 19.7%[f]	*n* = 303 27.7%[g]
Smoked cigarettes daily for 1+ months	*n* = 1794 3.0%	*n* = 925 2.6%	*n* = 870 3.4%	*n* = 634 0.2%[a]	*n* = 312 0%	*n* = 322 0.3%	*n* = 579 2.2%[b]	*n* = 276 1.4%	*n* = 303 3.0%	*n* = 577 6.8%[c]	*n* = 332 5.7%	*n* = 245 8.2%
Past-Month Tobacco Use												
Smoked 1+ days	*n* = 1803 2.8%	*n* = 928 2.6%	*n* = 875 3.7%	*n* = 634 0.2%[a]	*n* = 312 0%	*n* = 322 0.3%	*n* = 582 2.6%[b]	*n* = 276 1.1%	*n* = 306 3.9%	*n* = 584 7.0%[c]	*n* = 336 6.3%	*n* = 248 8.1%
# of cigarettes smoked	*n* = 1778 3.9 (36.4)	*n* = 918 3.4 (32.1)	*n* = 860 4.4 (40.5)	*n* = 634 0[a] (0.4)	*n* = 312 0 (0)	*n* = 321 0 (0.6)	*n* = 568 0.2[a] (4.7)	*n* = 274 0.2 (4.3)	*n* = 295 0.3 (5.1)	*n* = 572 11.8[b] (63.4)	n = 328 9.3 (53.1)	*n* = 243 15.2 (75.0)
Past-Year Alcohol Use												
Used alcohol	*N* = 1998 8.5%	*n* = 1018 8.4%	*n* = 980 8.6%	*n* = 661 1.5%[a]	*n* = 322 0.9%	*n* = 339 2.1%	*n* = 644 6.7%[b]	*n* = 305 7.9%	*n* = 339 5.6%	*n* = 688 17.0%[c]	*n* = 387 15.2%	*n* = 301 19.3%
Engaged in binge drinking	*n* = 1995 4.0%	*n* = 1016 4.4%	*n* = 979 3.6%	*n* = 662 0.5%[a]	*n* = 323 0.6%	*n* = 339 0.3%	*n* = 644 2.8%[b]	*n* = 305 3.3%	*n* = 338 2.4%	*n* = 686 8.6%[c]	*n* = 385 8.6%	*n* = 301 8.6%
Past-Month Alcohol Use												
# of drinks consumed	*n* = 1994 0.5 (4.8)	*n* = 1017 0.6 (5.5)	*n* = 977 0.5 (3.8)	*n* = 662 0[a] (0.3)	*n* = 323 0 (0)	*n* = 339 0 (0.4)	*n* = 642 0.6 (6.3)	*n* = 305 0.8 (8.3)	*n* = 337 0.4 (3.8)	*n* = 686 1.0[b] (5.3)	n = 386 0.9 (5.2)	*n* = 300 1.2 (5.4)
Engaged in binge drinking	*n* = 1923 1.2%	*n* = 976 1.2%	*n* = 947 1.2%	*n* = 656 0%[a]	*n* = 319 0%	*n* = 337 0%	*n* = 619 0.8%[b]	*n* = 291 1.0%	*n* = 328 0.6%	*n* = 644 2.8%[c]	*n* = 363 2.5%	*n* = 281 3.2%
SA – 2+ CRAFFT Threshold												
Lifetime	*n* = 1995 5.3%	*n* = 1015 4.8%	*n* = 980 5.8%	*n* = 662 1.4%[a]	*n* = 323 0.9%	*n* = 339 1.8%	*n* = 640 4.7%[b]	*n* = 303 3.6%	*n* = 337 5.6%	*n* = 688 9.6%[c]	n = 386 9.1%	*n* = 303 10.6%
Since Tornado	*n* = 1996 3.2%	*n* = 1016 3.0%	*n* = 980 3.5%	*n* = 663 0.9%[a]	*n* = 323 0.3%	*n* = 339 1.2%	*n* = 641 3.0%[b]	*n* = 303 2.0%	*n* = 337 3.9%	*n* = 688 5.7%[c]	*n* = 385 5.7%	*n* = 303 5.6%
SA – 1+ CRAFFT Threshold												
Lifetime	*n* = 1995 19.1%	*n* = 1016 18.3%	*n* = 980 20.0%	*n* = 663 9.4%[a]	*n* = 323 7.4%	*n* = 338 10.9%	*n* = 641 18.4%[b]	*n* = 303 18.5%	*n* = 338 18.3%	*n* = 688 29.2%[c]	*n* = 385 27.0%	*n* = 303 32.0%
Since Tornado	*n* = 1995 11.3%	*n* = 1016 10.6%	*n* = 980 11.9%	*n* = 663 4.5%[a]	*n* = 324 3.1%	*n* = 339 5.9%	*n* = 640 12.0%[b]	*n* = 304 12.2%	*n* = 338 12.1%	*n* = 688 17.2%[c]	n = 386 16.1%	*n* = 303 18.5%

Note. Standard deviations for the number of cigarettes smokes and number of drinks consumed are presented in parentheses. Statistically significant differences in prevalence and descriptive statistics are indicated by different superscript letters ($p < .05$). Data were weighted to enhance the generalizability of the sample to the larger population of the communities from which they were recruited. Some subsample sizes differ from the total sample sizes due to rounding or missing data.

Table 3

Hierarchical Linear Regression Results: Risk Factors for Number of Cigarettes Smoked and Number of Alcoholic Drinks Consumed in the Past Month

	Step					Final Model				
Risk Factor	***b***	***SE***	**95% CI**	***β***	***t***	***b***	***SE***	**95% CI**	***β***	***t***
Regression A: Number of Cigarettes Smoked in the Past Month (n = 1327)										
Step 1: $F(5, 1321) = 7.97$, $p < .0001$, $R^2 = .03$										
Gender	1.10	2.10	[−3.01, 5.21]	0.01	0.53	0.28	2.10	[−3.84, 4.39]	0.004	0.13
Age	3.24	0.60	[2.06, 4.43]	0.15***	5.38	2.82	0.60	[1.65, 3.99]	0.13***	4.71
African-American	−3.92	2.42	[−8.66, 0.82]	−0.05	−1.62	−7.47	2.62	[−12.60, −2.34]	−0.09**	−2.86
Other race	15.20	5.69	[4.04, 26.37]	0.07**	2.67	14.29	5.63	[3.24, 25.34]	0.07*	2.54
Hispanic	2.60	6.38	[−9.92, 15.12]	0.01	0.41	−0.40	6.28	[−12.72, 11.92]	−0.002	−0.06
Step 2: F *change*$(3, 1318) = 9.40$, $p < .0001$, R^2 change = .02										
Parent distress	0.17	0.23	[−0.28, 0.63]	0.02	0.76	−0.07	0.24	[−0.55, 0.41]	−0.01	−0.29
Fam history of subs	13.08	2.85	[7.49, 18.66]	0.13***	4.59	10.22	2.90	[4.53, 15.91]	0.10***	3.52
Income	−0.95	0.61	[−2.15, 0.26]	−0.05	−1.55	−0.66	0.61	[−1.86, 0.54]	−0.03	−1.08
Step 3: F *change*$(2, 1316) = 14.14$, $p < .0001$, R^2 change = .02										
Prior natural disaster	−6.18	2.77	[−11.61, −0.75]	−0.07*	−2.23	−5.60	2.79	[−11.08, −0.13]	−0.07*	−2.01
Prior trauma exposure	6.18	1.17	[3.88, 8.49]	0.18***	5.27	6.13	1.21	[3.76, 8.51]	0.17***	5.07
Step 4: F *change*$(8, 1308) = 1.26$, $p = .26$, R^2 change = .007										
Time since tornado						−0.88	0.42	[−1.70, −0.06]	−0.06*	−2.10
Parent present						−2.04	3.43	[−8.78, 4.69]	−0.02	−0.60
Parent injured						−4.02	6.43	[−16.62, 8.58]	−0.02	−0.63
Concerned for others						−1.06	2.39	[−5.75, 3.63]	−0.01	−0.44
Displacement > 1 week						1.56	4.44	[−7.14, 10.27]	0.01	0.35
Property damage						0.07	0.78	[−1.45, 1.59]	0.003	0.09
Loss of services						2.27	1.42	[−0.52, 5.06]	0.05	1.60
PTSD since tornado						−0.77	4.22	[−9.05, 7.52]	−0.01	−0.18
Regression B: Number of Alcoholic Drinks Consumed in the Past Month (n = 1494)										

	Step					Final Model				
Risk Factor	***b***	***SE***	**95% CI**	***β***	***t***	***b***	***SE***	**95% CI**	***β***	***t***
Step 1: $F(5, 1488) = 4.92$, $p < .0001$, $R^2 = .02$										
Gender	0.09	0.21	[−0.33, 0.51]	0.01	0.41	0.05	0.22	[−0.37, 0.48]	0.01	0.25
Age	0.29	0.06	[0.17, 0.41]	0.12^{***}	4.71	0.24	0.06	[0.12, 0.36]	0.10^{***}	3.95
African-American	−0.27	0.25	[−0.76, 0.22]	−0.03	−1.09	−0.55	0.27	[−1.07, −0.02]	-0.06^{*}	−2.04
Other race/ethnicity	0.45	0.56	[−0.66, 1.56]	0.02	0.80	0.29	0.56	[−0.82, 1.39]	0.01	0.51
Hispanic	−0.25	0.65	[−1.52, 1.02]	−0.01	−0.38	−0.42	0.64	[−1.68, 0.83]	−0.02	−0.66
Step 2: F *change*$(3, 1485) = 6.29$, $p < .0001$, R^2 change = .01										
Parent distress	0.01	0.02	[−0.03, 0.06]	0.02	0.55	0.004	0.03	[−0.05, 0.05]	0.004	0.15
Fam history of subs	1.11	0.28	[0.57, 1.65]	0.11^{***}	4.03	0.77	0.28	[0.22, 1.33]	0.07^{**}	2.73
Income	−0.04	0.06	[−0.16, 0.09]	−0.02	−0.60	−0.01	0.06	[−0.13, 0.12]	−0.003	−0.12
Step 3: F *change*$(2, 1483) = 7.11$, $p = .001$, R^2 *change* = .01										
Prior natural disaster	−0.57	0.28	[−1.12, −0.01]	-0.06^{***}	−2.01	−0.55	0.28	[−1.10, 0.01]	-0.06^{+}	−1.93
Prior trauma exposure	0.44	0.12	[0.21, 0.66]	0.12^{***}	3.77	0.37	0.12	[0.13, 0.60]	0.10^{**}	3.06
Step 4: F *change*$(8, 1475) = 2.58$, $p = .01$, R^2 *change* = .01										
Time since tornado						−0.05	0.04	[−0.13, 0.04]	−0.03	−1.16
Parent present						−0.45	0.36	[−1.16, 0.27]	−0.03	−1.23
Parent injured						−0.30	0.65	[−1.57, 0.98]	−0.01	−0.46
Concerned for others						−0.32	0.25	[−0.80, 0.17]	−0.03	−1.27
Displacement > 1 week						0.01	0.46	[−0.88, 0.91]	0.001	0.03
Property damage						−0.16	0.08	[−0.32, −0.01]	-0.07^{***}	−2.08
Loss of services						0.33	0.14	[0.04, 0.61]	0.07^{**}	2.26
PTSD since tornado						1.18	0.40	[0.40, 1.96]	0.08^{**}	2.96

Note: CI = confidence interval; Fam history of subs = perceived family history of substance abuse problems; PTSD = posttraumatic stress disorder

$^{***}p < .0001$

$^{**}p < .01$

$^{*}p < .05$

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$^{+}p < .10$

Table 4

Hierarchical Logistic Regression Results: Risk Factors for Engaging in Binge Drinking in the Past Month and Substance Abuse Since the Tornado

	Step					Final Model				
Risk Factor	***B***	***SE***	***W***	**OR**	**95% CI**	***B***	***SE***	***W***	**OR**	**95% CI**
Regression A: Binge Drinking in the Past Month (n = 1440)										
Step 1: $\chi^2(5, n = 1440) = 35.20, p < .0001$										
Gender	−0.03	0.44	0.003	0.98	[0.41, 2.30]	0.03	0.49	0.003	1.03	[0.39, 2.69]
Age	0.91	0.22	17.34	2.49***	[1.62, 3.82]	0.91	0.23	16.08	2.49***	[1.59, 3.88]
African-American	−1.21	0.76	2.57	0.30	[0.07, 1.31]	−1.99	0.88	5.18	0.14*	[0.03, 0.76]
Other race/ethnicity	0.77	0.78	0.98	2.16	[0.47, 9.97]	0.54	0.88	0.38	1.72	[0.31, 9.54]
Hispanic	0.74	1.07	0.47	2.09	[0.25, 17.14]	0.88	1.11	0.62	2.41	[0.27, 21.34]
Step 2: $\chi^2(3, n = 1440) = 12.08, p = .01$										
Parent distress	−0.01	0.05	0.06	0.99	[0.90, 1.08]	−0.05	0.05	0.78	0.96	[0.87, 1.06]
Fam history of subs	1.62	0.46	12.38	5.05***	[2.05, 12.46]	1.28	0.52	6.17	3.60*	[1.31, 9.88]
Income	0.07	0.13	0.23	1.07	[0.82, 1.39]	0.15	0.14	1.13	1.16	[0.88, 1.52]
Step 3: $\chi^2(2, n = 1440) = 11.16, p = .004$										
Prior natural disaster	−0.79	0.55	2.09	0.45	[0.16, 1.32]	−0.85	0.56	2.25	0.43	[0.14, 1.30]
Prior trauma exposure	0.65	0.19	11.57	1.91**	[1.32, 2.78]	0.61	0.21	8.60	1.84**	[1.23, 2.77]
Step 4: $\chi^2(8, n = 1440) = 7.15, p = .52$										
Time since tornado						0.13	0.10	1.64	1.14	[0.93, 1.38]
Parent present						−0.80	0.82	0.97	0.45	[0.09, 2.22]
Parent injured						0.92	1.21	0.58	2.52	[0.24, 27.03]
Concerned for others						−0.30	0.54	0.31	0.74	[0.26, 2.12]
Displacement > 1 week						−0.37	1.05	0.13	0.69	[0.09, 5.35]
Property damage						−0.10	0.17	0.31	0.91	[0.65, 1.27]
Loss of services						0.60	0.29	4.19	1.82*	[1.03, 3.24]
PTSD since tornado						0.67	0.64	1.08	1.95	[0.55, 6.85]
Regression B: Substance Abuse Since the Tornado based on CRAFFT 2+ cutoff (n = 1497)										

	Step					Final Model				
Risk Factor	***B***	***SE***	***W***	**OR**	**95% CI**	***B***	***SE***	***W***	**OR**	**95% CI**
Step 1: $\chi^2(5, n = 1497) = 24.93, p < .0001$										
Gender	0.13	0.29	0.21	1.14	[0.65, 2.02]	0.15	0.34	0.18	1.16	[0.60, 2.24]
Age	0.43	0.10	19.44	1.54***	[1.27, 1.86]	0.37	0.11	11.57	1.44**	[1.17, 1.78]
African-American	0.35	0.33	1.17	1.42	[0.75, 2.69]	−0.21	0.40	0.27	0.81	[0.37, 1.78]
Other race/ethnicity	0.61	0.63	0.95	1.85	[0.54, 6.34]	0.44	0.70	0.40	1.55	[0.40, 6.06]
Hispanic	0.65	0.76	0.73	1.91	[0.43, 8.44]	0.31	0.87	0.13	1.37	[0.25, 7.54]
Step 2: $\chi^2(3, n = 1497) = 44.97, p < .0001$										
Parent distress	−0.01	0.03	0.14	0.99	[0.93, 1.05]	−0.05	0.04	1.70	0.96	[0.89, 1.02]
Fam history of subs	1.97	0.31	39.62	7.18***	[3.89, 13.27]	1.51	0.35	19.04	4.52***	[2.30, 8.91]
Income	−0.08	0.09	0.78	0.92	[0.77, 1.10]	−0.02	0.10	0.03	0.98	[0.82, 1.18]
Step 3: $\chi^2(2, n = 1497) = 40.88, p < .0001$										
Prior natural disaster	−0.38	0.36	1.12	0.69	[0.34, 1.38]	−0.44	0.37	1.39	0.65	[0.31, 1.34]
Prior trauma exposure	0.79	0.13	35.63	2.20***	[1.70, 2.85]	0.78	0.15	27.73	2.17***	[1.63, 2.90]
Step 4: $\chi^2(8, n = 1497) = 17.05, p = .03$										
Time since tornado						0.10	0.07	2.09	1.11	[0.96, 1.28]
Parent present						−1.30	0.47	7.71	0.27**	[0.11, 0.68]
Parent injured						−0.65	1.28	0.26	0.52	[0.04, 6.37]
Concerned for others						0.05	0.40	0.02	1.05	[0.48, 2.30]
Displacement > 1 week						−0.13	0.70	0.03	0.88	[0.23, 3.46]
Property damage						−0.11	0.12	0.81	0.90	[0.71, 1.14]
Loss of services						0.28	0.20	1.89	1.32	[0.89, 1.96]
PTSD since tornado						0.92	0.38	5.87	2.50***	[1.19, 5.25]

Note: CI = confidence interval; Fam history of subs = perceived family history of substance abuse problems; PTSD = posttraumatic stress disorder

*** $p < .0001$

** $p < .01$

* $p < .05$