Effects of 9/11-Related Posttraumatic Stress Disorder on Problem Alcohol Use Among World Trade Center Health Registry Enrollees

by

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Abstract

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by

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As a result of the 9/11 terrorist attacks on the World Trade Center, thousands of individuals experienced traumatic events. Although the prevalence of posttraumatic stress disorder (PTSD) after 9/11 is well known, little is known about how those affected have coped with their posttraumatic stress symptoms. Alcohol use has been described as both a coping strategy and a form of self-medication used by individuals to reduce the effects of mental health conditions, such as PTSD. While literature on the consequences of 9/11 terrorist attacks on problem drinking is limited, the existing body of findings to date is consistent with other disasters, showing an association between PTSD and problem drinking.

Data from the World Trade Center Health Registry, the largest registry of individuals directly exposed to an urban disaster, were used to examine the association between PSTD and alcohol use. The study found that 16% of enrollees were identified as having probable PTSD on its first survey (2003-04) and 19% on its second survey (2006-07). At the second survey, 29.3% of respondents reported problem drinking, a category combining binge drinking and/or heavy drinking and 48.6% reported non-problem drinking. This study showed that survivors of complex disasters with PTSD are at increased risk for problem

drinking. Furthermore, it shows that the association between PTSD and problem drinking varies by age, race/ethnicity and gender and post-disaster experiences.

This study also showed that populations living in dense urban areas who are directly exposed to disasters face higher risks of having mental health problems than other studies reported for the general population living in the affected area. Despite the fact that the events of 9/11 were unique, other complex emergencies that expose large numbers of people to a variety of traumatic events are not. As such, it is crucial that public health practitioners, particularly those working in disaster planning and mental health, include screening for increases in alcohol use and problem drinking as part of post-disaster psychological evaluations and ensure that mental health and alcohol treatment services are available in the period following a disaster.

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This dissertation is dedicated to the enrollees of the World Trade Center Health Registry.

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Chapter 1

Introduction

On September 11, 2001 two planes crashed into the Twin Towers of the World Trade Center, causing them and four other buildings to collapse.[1] As a result, thousands of individuals present in lower Manhattan-- area residents, area workers, school students and staff and rescue/recovery personnel-- experienced numerous traumatic events. These included being caught in the dust and debris cloud, witnessing horror, sustaining an injury, participating in rescue, recovery and clean-up activities, as well as being evacuated from work or home.[1] Furthermore, in the months following 9/11, many of these same individuals experienced job loss, disability or the loss of a loved one.[2] The World Trade Center Health Registry (Registry), established by the Agency for Toxic Substances and Disease Registry (ATSDR) and the New York City Department of Health and Mental Hygiene in 2002 to monitor the health of those affected by the events of September 11th and its aftermath, found that 16% of enrollees had probable posttraumatic stress disorder (PTSD) at the time of its first survey (2003-04).[1] Nineteen percent of enrollees completing the Registry's second survey (2006-07) were found to have probable PTSD.[2] Although the prevalence of PTSD after 9/11 is well known, little is known about how those affected have coped with their posttraumatic stress symptoms.

While the events of 9/11 were unique, unfortunately, complex emergencies that expose large numbers of people to a variety of traumatic events are not. In recent decades, public health officials have recognized that terrorist or military attacks, natural disasters such as earthquakes and hurricanes, industrial accidents and other mass disruptions can impose acute and chronic health burdens on exposed populations, especially in dense urban areas where exposure levels are high. In recent years, researchers have also documented the importance of the acute and chronic mental health

consequences of exposure to urban disasters. This dissertation examines the associations between post traumatic stress disorder and problem alcohol use following one such disaster. Its goal is to provide insights that can guide public health practice and policy to reduce the public health burden of such events.

Prior research has demonstrated an association between exposures to psychological trauma and substance abuse, particularly problem drinking.[3-25] Alcohol use has been described as both a coping strategy and a form of self-medication used by individuals to reduce the effects of mental health conditions, such as posttraumatic stress disorder (PTSD).[3, 15, 26-28] While the literature on the consequences of the 9/11 terrorist attacks on problem drinking is limited, the existing studies on this event are consistent with findings from other disasters, which show an association of PTSD and traumatic exposures with alcohol use.[8-13, 15, 18, 19, 23]

According to a report from the National Center for Health Statistics, after adjusting for age, 5% of adults in the United States reported heavy drinking and 20.2% reported binge drinking in the 12 months prior to the survey in 2006.[29] Among residents of New York City, the site of the 9/11 disaster, prior 30 day drinking estimates appear to be lower than the national average for prior 12 month drinking. According to the 2007 NYC Community Health Survey (CHS), a population-based telephone survey of New York City residents, 5.2% of that sample reported heavy drinking and 15.8% reported at least one episode of binge drinking in the last 30 days.[30] Moreover, national and local data suggest that problem alcohol use is generally more frequent among males and non-Hispanic Whites.[29, 31] These data also show that binge drinking is more frequent among

young adults aged 18 to 24, while heaving drinking is more common among 45-54 year olds.[29, 31]

Outside the context of disasters, the epidemiology of PTSD is fairly well described in terms of burden and sociodemographic risk factors. Current studies suggest that while about 80-90% of adults have experienced at least one traumatic event in their lifetime, the lifetime prevalence of posttraumatic stress disorder (PTSD) in the US is estimated to be less than 10%[32-36], with women exhibiting twice the prevalence of men.[35] This discrepancy implies that factors other than experiencing a traumatic exposure influence the development of PTSD.[32, 33, 37-39] PTSD development can be affected by the type and number of traumatic exposure(s).[32, 40] For example, individuals experiencing war-related events, race-related violence, or childhood maltreatment are more likely to develop PTSD, as are those experiencing multiple traumas.[40] Groups at higher risk for PTSD include: younger persons, women, Latinos, those with a lack of social support or previous history of traumatic exposures or personal/family history of mental illness, and individuals with lower education or income or who reside in urban areas.[32, 33, 40-43]

While there is a considerable body of literature documenting the significant relationship between PTSD and alcohol and other substance use[6, 24, 25, 37, 44], the literature on alcohol use among those affected by the events of 9/11 examines risk factors associated with problem drinking such as PTSD, sociodemographic characteristics and traumatic exposures. However, these studies do not examine how these factors affect the association between PTSD and alcohol use.[6, 24, 25, 37, 44] This study will be one of the first efforts to investigate the effects of 9/11-related PTSD on problem alcohol use in a population comprised entirely of individuals directly exposed to the disaster. In addition,

given the large sample size available from the World Trade Center Health Registry, it also will be one of the first with the power to examine the heterogeneity of this association according to age, gender, race/ethnicity as well as peri- and post-disaster experiences.

Specific Aims

The specific aims of this dissertation are: 1) to systematically review the literature on the association between PTSD and alcohol use; 2) to investigate (a) the relationships between PTSD and problem drinking among enrollees in the World Trade Center Health Registry (Registry) before and after controlling for sociodemographic characteristics (age, gender, race/ethnicity, marital status, education, income, cigarette smoking, history of depression and mode of enrollment) and (b) to examine whether the strength of this association varies with age, gender and race/ethnicity; and 3) to investigate the relationship between PTSD and problem drinking among Registry enrollees before and after controlling for age, gender, race/ethnicity, marital status, education, income, cigarette smoking, history of depression, mode of enrollment and peri- and post-disaster experiences and to examine whether the strength of this association varies according to peri- and post-disaster experiences.

Overview of Chapters 2 to 6

The following five chapters describe the methods and findings of this study and examine its implications for public health research and practice. Chapter 2 provides a description of the methods used in the literature review and each of the analytic papers. Chapter 3

reviews selected literature on the association between PTSD and problem drinking and summarizes the findings from this body of work. Chapter 4 investigates the association between PTSD and problem drinking among Registry enrollees with consideration of sociodemographic characteristics (specific aim two). Chapter 5 expands upon the analysis in the previous chapter to examine the impact of peri- and post-disaster experiences on the association between PTSD and problem drinking. Finally, Chapter 6 summarizes the study findings; describes the study's strengths and limitations; and discusses the policy implications and recommendations for public health research and practice.

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Chapter 2

Methods

Methods

This chapter describes the methods used to address the specific aims of the dissertation.

Aim 1

Aim 1 is a review of selected literature on PTSD and problem drinking. English-language articles published between 1990 and November 2010 with data on either PTSD or alcohol use (alcohol abuse or dependence, heavy, binge or problem drinking) were located in bibliographic databases, recent journal issues, and secondary sources like journal articles and book chapters. Academic Search Complete (EBSCO Industries), PubMed and the PILOTS (**P**ublished **I**nternational **L**iterature **o**n **T**raumatic **S**tress) database managed by the National Center for PTSD were searched using the terms 'alcohol', 'alcohol and PTSD', and 'binge drinking and PTSD'. This method of searching was used to maximize the number of articles for selection for the review.

Articles describing group studies were included if they met the following criteria: 1) the study investigated the association between PTSD and problem drinking or specifically examined the impact of 9/11 on problem drinking; 2) the study included a valid PTSD assessment (e.g., a questionnaire with all PTSD symptoms included and a valid cutoff score or diagnostic interview); 3) a valid assessment of alcohol use (e.g., self-reported alcohol consumption, an alcohol use questionnaire (e.g., Alcohol Use Disorders Identification Test (AUDIT) or CAGE questionnaire) or diagnostic interview); 4) the study considered alcohol use separate from other substance use disorders; and 5) the study included a community, military, clinical or specific trauma sample.

A total of 37 relevant articles were found of which 54% (n=20) met the inclusion criteria. Among the excluded studies were: seven studies that did not examine the association between PTSD and alcohol use and only discussed the two conditions separately or suggested that PTSD was the reason for problem drinking without examining the association[1-7], two studies that did not differentiate alcohol use disorders from other substance use disorders[8, 9], two studies that did not examine alcohol use[10, 11] and one study that did not examine PTSD.[12] Finally, five studies that included duplicate cohorts were also excluded: a study sample of survivors of the Oklahoma City bombing[13] used by North et al. was included, however a second study by North[14] used the same study population and was excluded; the cohort of university employees used by Richman et al.[15] was also used in two other publications by Richman et al.[16, 17], which were excluded; and the study sample of NYC residents used in the study by Boscarino et al.[18] was used in two studies published by Adams et al.[19, 20], which were excluded.

Aims 2 and 3

World Trade Center Health Registry Survey: 2003-04, 2006-07. The Registry was established in 2002 by the Agency for Toxic Substances and Disease Registry (ATSDR) and the New York City Department of Health and Mental Hygiene to monitor the long term physical and mental health effects of 9/11 on those directly exposed.[21, 22] Recruitment was conducted through outreach to eligible groups and individuals as well as via local and regional media campaigns from 2003 through 2004.[21, 22] Four broad eligibility groups were created for enrollment into the Registry: 1) people who were present south of Chambers Street in lower Manhattan on the morning of 9/11; 2) workers and volunteers involved in rescue, recovery and clean up efforts at the WTC site, the

Staten Island Recovery Operations Center or on a transport barge from the WTC site; 3) people with primary residence south of Canal Street in lower Manhattan on 9/11; 4) students and staff of schools (grades pre-K to 12) south of Canal Street on 9/11.[21, 22] Approximately 409,492 people fit into at least one of these groups and were eligible for enrollment in the Registry. Details on the calculation methods have been published elsewhere.[21, 22]

The Registry is a non-probability based sample, where every available subject was selected.[22] Individuals were recruited for enrollment in several ways. The Registry was able to obtain 232 lists of names and contact information representing 135,450 eligible individuals from governmental agencies and employers, including information on potential WTC building survivors.[21, 22] Individuals on lists were recruited by telephone or letter and once enrolled were classified as "list-identified". Outreach was also conducted to potentially eligible individuals and groups directly (tabling and leaflets in neighborhood residences, subway stations and offices) and using local and regional media.[21] Advertising campaigns directed people to enroll using a toll-free number or website.[21, 22] Individuals enrolling in this manner were classified as "self-identified".[21]

The Registry was able to recruit and enroll 71,437 eligible individuals (68,802 adults and 2,635 children), representing rescue/recovery workers, area residents, area workers, passers-by and students and staff from area schools.[21, 22] Approximately 30% of those enrolled came from lists, while the remaining 70% self-enrolled either by phone or on-line.[23] The Wave 1 survey was administered to all 71,437 enrollees via telephone surveys and in-person interviews from September 2003 through November 2004.[21, 24] Surveys were administered in English, Spanish, Mandarin and Cantonese.[21] Data on

children were collected by proxy interview with a parent or guardian.[21] Data collected included information about specific 9/11 activities and exposures, sociodemographic characteristics, and physical and mental health outcomes.

Wave 2 was conducted from November 2006 through December 2007. Surveys were completed on 46,602 enrollees, yielding a response rate of 68.5%.[24] Internet-based survey, mail survey and telephone survey were the modes of administration for the Wave 2 survey.[24] Data were initially collected via internet (English only survey instruments were sent to those with a valid e-mail address) or by mail (paper surveys in the same language as Wave 1).[24] Enrollees received numerous reminders (either postcards or emails with links to the web-based survey) beginning three weeks after the survey was launched.[24] A total of six e-mail and three postcard reminders were sent as well as two additional rounds of paper questionnaires to mail and web non-respondents.[24] During the last three months of data collection, at least one attempt was made to enroll remaining non-respondents for telephone survey participation.[24] The majority of enrollees completed the Wave 2 survey by mail (46%) or by web (42%), the remaining 12% of enrollees completed the survey by phone. Underrepresented enrollee groups (list-identified, household income < $35,000, young adults, sanitation workers, Spanish and Chinese speakers, and lower Manhattan Residents) received up to 30 call attempts for telephone survey participation.[24] Data collected at Wave 2 include current mental and physical health status, health care utilization, risk behaviors (tobacco and alcohol use), clarification of reported Wave 1 exposures, quality of life measures and health care utilization.[24] Overviews of the WTCHR, methods, recruitment activities and findings from Waves 1 and 2 have been previously published elsewhere.[21, 22, 24-26]

Analytic Sample

Of the 68,802 enrollees that were age 18 and older at both the Wave 1 and Wave 2 surveys, only 67% (n=46,374) completed the Wave 2 survey. Enrollees not completing the Wave 2 survey were not included in this study because the outcome of interest (alcohol use) was only assessed at Wave 2. Enrollees with a PTSD diagnosis prior to 9/11 (n=568) were excluded, because a prior history of PTSD is a risk factor for alcohol use as well as developing PTSD after another traumatic exposure.[9, 11, 27-29] Of the remaining respondents, those not completing the PTSD questionnaires at both waves (n=2,740), not responding to the alcohol use questions (n=1,786), and those missing information on any of the key covariates included in the analysis (n=2,978) were excluded. The final sample size was 38,302 (See Appendix A). We compared the characteristics of the enrollees that were included and excluded (prior history of PTSD or missing data) from the analysis. In particular, those that were excluded were less likely than those included to report either problem (23.3% vs. 29.3%, P-value<0.001) or non-problem drinking (42.9% vs. 48.6%, P-value<0.001) but were more likely to have PTSD (24.5% vs. 18.6%, P-value <0.001). In addition, the two groups differed significantly across all sociodemographic characteristics examined, such as age, gender, race/ethnicity, marital status, education, household income, history of depression, and mode of enrollment (P-value <0.001 see Appendix B).

Outcome Variable

The outcome, self-reported alcohol use in the last 30 days was evaluated using a polytomous variable (no drinking, non-problem drinking, and problem drinking), which

was derived from enrollees' responses to the following questions from the Wave 2 survey: "During the last 30 days, how many days per week or per month, did you have at least one drink of any alcoholic beverage?", "On the days when you drank, about how many drinks did you drink on average?" and "Considering all types of alcoholic beverages, how many times during the last 30 days did you have 5 or more drinks on one occasion?"

Respondents were categorized as engaging in problem drinking if they reported either any binge drinking or a pattern of heavy drinking in the past 30 days. In addition, their average daily alcohol consumption was used to classify individuals as binge or heavy drinkers. Average daily alcohol consumption was calculated by multiplying the number of drinking days by the average number of drinks per drinking day, then dividing this sum by 30 (days). Binge drinking was defined as having reported consuming five or more drinks on a single occasion in the last 30 days. Because the survey question that queried about episodes of binge drinking, asked for episodes of 5 or more drinks (the threshold for men), to accurately assess binge drinking in women (defined as four or more drinks on a single occasion) women reporting an average number of drinks per drinking day of four or more were also considered 'binge drinkers'. Furthermore, in order to capture men who did not accurately report binge drinking, men reporting an average number of drinks per drinking day of five or more were also considered 'binge drinkers.' Heavy drinking was defined as average daily alcohol consumption of more than two drinks per day for men and more than one drink per day for women. Binge and heavy drinking are not mutually exclusive, that is an individual that exhibits a pattern of heavy drinking may also report episodes of binge drinking. For the purpose of this analysis,

problem drinking was defined as binge drinking and/or heavy drinking. Because there was substantial overlap of the two categories and binge drinking was more common among young adults while heavy drinking was more common among older adults, we chose to combine binge and heavy drinking to define problem drinking. This allowed us to accurately capture problem drinking in this population.

Non-problem drinking was defined as alcohol use other than binge or heavy drinking. No drinking was defined as reporting no alcohol consumption in the last 30 days. The levels of the alcohol use variable and the corresponding survey questions are summarized in Appendix C.

Exposure Variable

The exposure was probable posttraumatic stress disorder (PTSD) at Wave 2**.** PTSD was assessed in the Registry surveys at both Waves 1 and 2 using the PTSD Checklist-Civilian Version (PCL-17). The PCL-17 is a self reported, 17-item scale that corresponds to the criteria in the DSM-IV and is useful to assess PTSD symptoms when clinical interviews are not feasible.[25, 30-32] Each of the 17 items corresponds to one of the 17 symptoms (Criteria B, C and D) of the DSM-IV diagnostic criteria.[30, 32] Each symptom was queried as specific to 9/11 and current (within the last 30 days).[24, 25] Respondents scored how much they were bothered by each symptom experienced on a five point scale (from *not at all* (1) to *extremely* (5)). PCL scores can range from 17 to 85, with most researchers using a cut-off score of 44 for civilians.[24, 25, 30] The PCL's psychometric properties have been reviewed by others (different settings and traumas) with sensitivity ranging from 0.94 to 0.97, specificity from 0.86 to 0.99, positive predictive value from

0.70 to 0.97 and diagnostic efficiency from 0.83 to 0.96.[24, 30, 32, 33] For this study, enrollees with a score of 44 or greater on the PCL-17 at Wave 2 are considered to have probable PTSD (hereafter referred to as PTSD) at Wave 2.[24, 25]

In addition, a person's PTSD trajectory was defined using the following categories between Waves 1 and 2: chronic (those reporting PTSD at Wave 1 and Wave 2), late onset (Wave 2 only), resolved (Wave 1 only), and no PTSD at either wave (see Appendix D).[24]

Covariates

Information on selected characteristics considered was obtained from both survey waves. All variables were categorical except age, which was used as both a continuous and categorical variable. Current age was asked of each enrollee at the time of the Wave 2 survey and a categorical variable was created with the following categories: 18-29, 30-44, 45-64 and 65+. Enrollees were asked their gender at Wave 2 and were categorized as either male or female.

Race/ethnicity was self-reported by each enrollee using US Census race and ethnicity categories at the Wave 1 interview. A composite variable was created, categorizing enrollees according to methods used in 2000 Census SF1 documentation of race codes.[23, 34] Enrollees answering "Yes" to the question "Are you Hispanic or Latino/a?" were categorized as Hispanic, regardless of their response to race. Race was collected using the following question: "Which of the following would you say is your race?"[23] Non-Hispanic enrollees were categorized according to their response to the race question.[23] The categories for race/ethnicity in the Registry data are as follows: non-

Hispanic white, non-Hispanic black or African-American, Hispanic or Latino, Asian (includes Native Hawaiian/Pacific Islander), multiracial and other races (includes American Indian/Alaskan Native/Unknowns). Hereafter, non-Hispanic white and black will be referred to as white and black. For the purpose of this analysis, the groups multiracial and other races were combined due to small sample size. Further, analyses suggest that these two groups did not differ significantly from each other on either the outcome or exposure of interest (P-values >0.05).

Enrollees were asked to report their current marital status at Wave 2. Marital status was placed into the following categories for this analysis: married/living with partner, divorced/separated/widowed or never married. Enrollees that were widowed were included with those that were divorced or separated due to small sample size (n=743). Education was collected by asking each enrollee to report the highest year of school completed at the Wave 1 interview. For analysis purposes, education was categorized as follows: less than high school graduate, high school/GED, some college, and college graduate/post-graduate. All enrollees were asked at Wave 1 for their 2002, pre-tax, household income and the following income categories were created: $\leq$\$24,999, \$25,000-49,999, \$50,000-74,999, 75,000-99,999, $\geq$ \$100,000 and missing income. Because of the large number of enrollees not reporting their income, a missing category was created and included in the analysis.

For this analysis, cigarette smoking at Wave 2 was considered, as previous studies have shown cigarette smoking to be associated with both PTSD and alcohol consumption.[35-39] Enrollees were asked if they currently smoke cigarettes every day, some days or not at all. Enrollees smoking every day or some days were considered

current smokers and enrollees replying ‘not at all’ were considered non-smokers. We also considered current or prior history of depression in this analysis because of its association with both the exposure and outcome of interest.[40-45] Enrollees were also asked at Wave 2 if they had ever been told they had depression. In this study, enrollees were considered to have depression regardless of whether they received their diagnosis before or after 9/11.

In order to adjust for selection bias, enrollees were categorized by mode of enrollment in the Registry: list-identified (active recruitment from lists of potentially eligible individuals) or self-identified (self-enrolled by phone or web in response to generalized outreach efforts).

In addition to the covariates described previously, the analysis for Aim 3 considered peri-and post-disaster experiences. On 9/11 and in the weeks thereafter, Registry enrollees experienced various events that have been demonstrated to increase the risk of negative mental health outcomes, such as PTSD and substance use.[21, 24-26] Experiences are based on self-report. For this study, eight different peri-disaster experiences were considered with information collected at both Waves 1 and 2.

Enrollees were asked at Wave 1 if they had been caught in the dust and debris cloud that resulted from the collapse of the Towers. Enrollees were also asked at Wave 1 if they had witnessed any of the following events: an airplane hitting the WTC, people falling or jumping from the WTC, buildings collapsing, people running away from the dust cloud or smoke and other people being injured or killed. Enrollees who witnessed at least one of these events were considered to have witnessed tragedy on 9/11. Enrollees were considered to have sustained an injury on 9/11 if they reported at least one of the following injuries sustained on 9/11 on the Wave 1 survey: burns, sprain/strain, fractured

or dislocated bones, cuts/abrasions/puncture wounds or head injury. At Wave 2, enrollees were asked "Did you think that you might be injured or killed during the WTC disaster on 9/11/01?" Enrollees answering yes were considered to have been afraid of injury or death on 9/11. Enrollees reporting at least one shift at the WTC rescue and recovery site or having worked at the State Island recovery site or barges on the Wave 1 survey were classified as rescue and recovery workers. In order to be consistent with previous studies on 9/11-related alcohol use, bereavement was included as a peri-disaster experience.[18, 46] Bereavement was defined as any enrollee responding yes to the Wave 2 question, "Did anyone you know die on 9/11/01 as a result of the WTC disaster?"

Enrollees that were lower Manhattan residents on 9/11 were asked at Wave 2, "During the period of September 11 to September 18, 2001 did you leave your home for at least 24 hours because of the WTC attack?" Those responding yes were considered displaced from their home in this analysis. At Wave 2, enrollees were also asked if they had lost their job since 9/11 and if so, was this a result of the events of September 11th. Those answering yes were considered to have experienced 9/11-related job loss.

The eight experiences were added and each enrollee was assigned an experience score ranging from 0 to 8 based on the number of experiences they reported. Next, they were categorized into one of five groups based on their experience score (0, 1 to 2, 3 to 4, 4 to 5 or 7 to 8) for comparison.

On the Wave 2 survey enrollees were asked a series of questions to determine their level of social support and a social support score ranging from 0 to 5 was created. Enrollees were given one point for each of the following: having at least one close friend, getting together with friends or relatives at least two to three times per month, attending

religious services at least two to three times per month, belonging to at least one group and being very or fairly active in a group. Enrollees with a score of two or less were considered to have low social support, while enrollees scoring three or greater were considered to have high social support.[24] At Wave 2, enrollees were asked if they had seen or talked to a professional for a mental or emotional problem in the last 12 months. Those responding yes were considered having seen a mental health professional in the last 12 months.

Data Analysis

Descriptive statistics were calculated for selected characteristics of the study population according to PSTD and alcohol use. To assess any significant association between PTSD and alcohol use, chi-square tests were used. Variables considered as confounders in previous studies were included as confounders in the present study.[9, 11, 18, 27-29, 35-46] In addition, because confounder is a data driven phenomenon, we evaluated the associations of each characteristic with PTSD and alcohol use to determine whether the covariate was associated with both PTSD and alcohol use, but was not on the causal pathway between the exposure and the outcome. Variables at least associated with the outcome ($P<0.10$) or considered confounders a priori and were included in the final model.

Multinomial regression analyses using generalized logit models were conducted to estimate the strength of the association between PTSD and alcohol use before and after adjusting for selected covariates. Crude and adjusted odds ratios (OR) and 95% confidence intervals (CI) were estimated. Specifically, four models were fitted to address Aim 2: Model 1-PTSD and alcohol use, unadjusted; Model 2-PTSD and alcohol use

adjusted for age, gender and race/ethnicity (adjusting for demographic characteristics); Model 3-additionally adjusted for marital status, education, income, smoking and depression (adjusting for additional demographic characteristics and other characteristics associated with alcohol use and PTSD); and Model 4-additionally adjusted for enrollment (to adjust for possible selection bias). To address Aim 3, six additional models were fitted: Model 5-additionally adjusted for the number of peri-disaster experiences; Model 6-additionally adjusted for social support (but not peri-disaster experiences); Model 7-additionally adjusted for mental health care utilization (but not social support or peri-disaster experiences); Model 8-additionally adjusted for social support and mental health care utilization (but not peri-disaster experiences); Model 9-additionally adjusted for peri-disaster experiences and mental health care utilization (but not social support); and Model 10-additionally adjusted for peri-disaster experiences, social support and mental health care utilization.

In order to determine whether there was heterogeneity of the association between PTSD and alcohol use according to age, gender and race/ethnicity, interaction terms between each covariate and PTSD were tested in the fully adjusted model (Aim 2). Likewise, to determine whether there was heterogeneity of the association between PTSD and alcohol use according to peri- and post-disaster experiences, interaction terms between each covariate (experience group, social support and mental health care utilization) and PTSD were tested in the fully adjusted model (Aim 3). However, to avoid issues of multicollinearity each interaction term was tested in a separate model. An a priori P-value of <0.05 was selected to determine significance. All data management and analyses were performed using SAS Version 9.2 (SAS Institute Inc., Cary, NC).

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Chapter 3

Posttraumatic Stress Disorder and Problem Alcohol Use:

A Selected Review of the Relevant Literature

Introduction

While there is a considerable body of literature documenting the significant relationship between alcohol and other substance use and PTSD[1-5], the literature focusing on post-9/11 alcohol use examines risk factors associated with different forms of alcohol consumption and problem drinking, but does not examine how these factors affect the association between PTSD and alcohol use.[1-5] This review will focus on the association between PTSD and problem drinking in trauma exposed populations, such as veterans and those experiencing disasters (man-made and natural), terrorism or other acts of violence.

Articles were divided into 4 categories: disaster exposed populations (9/11, other disasters or acts of terrorism), military personnel (veterans or active-duty), young adults, and other studies. The studies are summarized in Tables 3.1-3.4.

Results

Disaster Exposed Populations

A total of ten studies on disaster exposed populations were considered for this review (See Table 3.1).[1, 4-12] Only eight studies specifically examined the association between PTSD and problem drinking.[1, 4-6, 8, 9, 11, 12] Hasin et al.[7] and Richman et al.[10] they considered the effects of 9/11 on problem drinking. Six studies were among individuals exposed (directly or indirectly) to the 9/11 disaster[1, 4-7, 10], one study was among young adults exposed to political violence[11], one was on survivors of Hurricane Katrina[12], one was on survivors of the Oklahoma City bombing[8] and the final study was on survivors of 10 different disasters[9]. Five of eight (63%) studies found a positive association between

PTSD and problem drinking[1, 4, 5, 9, 12], while three (37%) found no association.[6, 8, 11] The remaining two studies found a positive association between 9/11 experiences and problem drinking.[7, 10]

The five studies that observed positive associations between PTSD and alcohol use were reviewed in detail to understand the magnitude and characterization of associations and to synthesize findings across studies. In general, these studies found 2-6 times higher prevalence of PTSD symptoms among persons screening positive for post-disaster problem drinking. In one, Vlahov et al.[1] examined the prevalence and incidence of alcohol drinking problems in the general NYC population six months after the events of 9/11. They used the CAGE questionnaire to assess for self-reported problem drinking before and after 9/11.[1] In addition to PTSD and depression, they considered the following covariates in their analyses: peri-disaster experiences (proximity to the disaster site, direct exposure to the attacks, fear, loss of loved ones as a result of the attacks, involvement in rescue efforts, job loss, displacement from home, panic attack following the attack, or loss of a possession as result of 9/11); current stressors and stressors prior to 9/11, lifetime history of traumatic events; social support and demographic characteristics (age, race/ethnicity, gender, income, education and marital status).[1]

Associations between drinking problems and PTSD were evaluated using PTSD symptoms "anytime since 9/11" and "current symptoms". The researchers considered five categories of problem drinking (before and after 9/11; after 9/11 but not before; before 9/11 but not after; problem drinking at either time; or no drinking at either time). Among those with PTSD symptoms anytime since 9/11, they found that those with drinking problems after 9/11were four to five times more likely than those without post-

9/11 drinking problems to have PTSD, with an apparent slightly higher prevalence of PTSD among those who had problem drinking at both time periods (34.2%) than problem drinking post-9/11 only (28%). However, the authors did not provide P-values or odds ratios for the bivariate association between PTSD symptoms and problem drinking. Levels of PTSD were similarly low for those reporting no problem drinking at each time period and no drinking (5% and 7%, respectively). Associations were similar for current (past month) PTSD symptoms, although prevalence of PTSD symptoms were lower.[1]

The authors further examined the associations between demographic characteristics, stressors and event exposure covariates and new-onset (after 9/11 but not before) problem drinking using bivariate logistic regression models. They found that age (less than 25 years old), low income, marital status, peri-disaster panic attack, lost possessions and 9/11 job loss to have had significant associations ($P<0.10$) with new onset problem drinking. Although the associations were not significant, their findings suggest that persons directly affected by the attack (present in the buildings, injured in the attack, lost a loved one, lost possessions, or involved in rescue and recovery work) were more likely to report new onset problem drinking than those not directly exposed. Lastly, women were more likely than men to report new onset problem drinking, as were Asians compared to other racial/ethnic groups (not statistically significant).[1]

North et al.[9] examined post-disaster alcohol use among survivors of ten disasters by compiling data from separate studies. Two interviews were conducted with 697 disaster survivors (index: one to six months post-disaster and follow-up: one to three years post-disaster). The presence of a pre- and/or post-disaster alcohol use disorder was determined by diagnostic interview. Compared to those without a post-disaster alcohol

use disorder, those with an alcohol use disorder experienced a significantly higher prevalence of post-disaster PTSD (28% vs. 18%) at index.[9] The prevalence of post-disaster PTSD among those with no alcohol use disorder found by North et al. was more than twice as high as the prevalence found by Vlahov et al. This is most likely attributable to the differences in measurement of alcohol use in each study. North et al. used clinical interviews to determine the presence of an alcohol use disorder, the prevalence of which is lower in the general population than problem drinking as assessed by Vlahov et al. As a result, more people screened positive for problem drinking in the Vlahov study than the North study. Many of the participants screening negative in North's study would likely have screened positive in Vlahov's.

Flory et al.[12] studied 209 adult survivors of Hurricane Katrina two to eight months after the disaster. Alcohol abuse was assessed using the full AUDIT questionnaire and PTSD was assessed using the IES-R. Seventy-two percent of participants reported current alcohol use, 36% of whom screened positive for hazardous or harmful drinking using the AUDIT cut-off score (>7). Using multiple linear regression modeling, the study found that a one unit increase in IES-R score was positively associated with an increase in AUDIT score (β=0.08, P<0.05).[12]

Berninger et al.[4] examined risk factors for the development of PTSD among 10,074 male firefighters from the Fire Department of New York (FDNY) that were involved in 9/11 rescue and recovery activities. Participants completed four questionnaires in yearly intervals from September 12, 2001 to September 11, 2005. In each of the four years, increased alcohol use was significantly associated with having PTSD after adjustment for age, WTC arrival, duration of WTC work, disability

retirement, number of deaths in the firehouse, emotional support, decrease exercise, counseling, and religious affiliation. At the year two interview, the odds of having PTSD was 3.2 times (95% CI: 2.0-5.2) greater among those with a self-reported increase in alcohol use post-9/11 compared to those not reporting increased alcohol use.[4]

Grieger et al.[5] examined PTSD and alcohol use among military and civilian staff in one of the Pentagon commands (n=77) that survived the 9/11 attack on the Pentagon. Participants completed internet-based anonymous questionnaires seven months after the attacks. PTSD was assessed using the Impact of Events Scale-Revised (IES-R). Participants were also asked if they had used more alcohol than they intended to since the attacks. The study found that those with PTSD were nearly six times more likely to report consuming more alcohol than intended than those without PTSD. The authors did not ask about pre-9/11 alcohol use and only presented crude associations without adjustment for other covariates.[5]

The three studies that did not find observed associations between PTSD and alcohol use were also reviewed in detail. Boscarino et al.[6] sought to examine the effect on exposure to psychological trauma (within the context of 9/11) on alcohol use. This was a two wave study conducted among 1,681 English or Spanish speaking adults that lived in NYC on 9/11. Wave one was completed one year after the disaster and wave two was completed the year after wave one. Participants were asked about daily alcohol consumption, binge drinking and were also asked to complete the CAGE questionnaire. PTSD was assessed using clinical interview. The researchers found a statistically significant increase in the amount of alcohol consumed post-disaster as well as between survey waves. Alcohol consumption was higher among those with college-education,

men, unmarried, whites, those with higher income, those with more 9/11 experiences, and those with higher social support compared to their counterparts in each category. After controlling for other risk factors (age, gender, race, education, marital status , lifetime history of traumatic events, history of antisocial behavior, social support, self-esteem and PTSD), they found a positive association between 9/11 experiences and drinks per month, alcohol dependence at both waves as well as drinks per day and binge drinking at wave one. However, after controlling for other risk factors (age, gender, race, education, marital status , lifetime history of traumatic events, history of antisocial behavior, social support, self-esteem and 9/11 experiences),there was no association between PTSD and alcohol consumption, alcohol dependence or binge drinking.[6] It is likely that no association was found in this study because it was a general population sample, with a low (4%) overall prevalence of PTSD in the past year.

North et al.[8] examined PTSD and alcohol use among survivors of the Oklahoma City bombing. They found no post-disaster alcohol abuse or dependence in participants that did not have a pre-disaster alcohol disorder. They also found no association between PTSD and alcohol use disorders.[8] Schiff et al.[11] examined alcohol use and PTSD among Israeli youths exposed to terrorism. The study found no correlation between alcohol use and PTSD symptoms. However, when controlling for symptoms of PTSD and depression, greater alcohol consumption was positively associated with psychological (knowing someone that was injured or killed in a terrorist attack) and physical proximity to terrorist attacks.[11]

The two studies that explicitly examined relationships between 9/11 exposures and alcohol use were also reviewed in detail. Richman et al.[10] interviewed a cohort of

staff and faculty of a Midwestern university both before and after 9/11. Although this population was not directly (i.e., physically) exposed to the 9/11 disaster, the researchers assessed participants' terrorism-related beliefs post 9/11. They found an association of high terrorism-related negative beliefs and fears, workplace stressors, and inadequate social bonds with increased drinking after 9/11.[10] Hasin et al.[7]surveyed 791 drinkers in a New Jersey community sample. Data were obtained both before and after 9/11. Alcohol dependence was assessed using the AUDADIS (Alcohol Use Disorder and Associated Disabilities Interview Schedule). This study did not examine the effect of PTSD on alcohol consumption. This study did find that participants who were within five miles of the WTC on 9/11 were 1.5 times more likely to have an alcohol use disorder four months after the disaster than those who were more than 5 miles away from the disaster site.[7]

Military Personnel

Five studies examined the association between PTSD and problem drinking in military personnel and were included in this review (See Table 3.2).[13-17] Two studies were on Vietnam veterans[14, 15], one study was on veterans of the Korean War and World War II[13] and two focused on veterans from the wars in Iraq and Afghanistan.[16, 17] All five studies found a positive association between PTSD and problem drinking.[13-17]

The National Vietnam Veterans Readjustment Study (NVVRS) was conducted among Vietnam veterans in 1986 and 1987, approximately 20 years following discharge from military service.[14] At the time of the NVVRS, 15.2% of all male Vietnam veterans continued to suffer from PTSD and 11.2% had an alcohol related disorder. The NVVRS

found that 75% of male veterans with PTSD had a lifetime history of an alcohol related disorder and 22% with active PTSD also had current alcohol abuse or dependence.[14]

Scherrer et al.[15] studied PTSD and problem drinking among 5,312 male-male twin pairs from the Vietnam Era Twin Registry (VET). The VET is a national registry of male-male twin pairs that served in the military during the Vietnam era. Data on PTSD and alcohol use were collected using diagnostic interviews in 1987 and 1992. Among participants with PTSD the prevalence of alcohol dependence among low, medium and high combat was 79%, 67% and 67%. This was more than twice the prevalence among those without PTSD of 30%, 36%, and 32%. In regression analyses that included PTSD and combat level, PTSD was significantly associated with alcohol dependence (OR=3.6; 95% CI: 2.8-4.6). In this study, the researchers were primarily interested in genetic contributions to PTSD and alcohol dependence. Their findings suggested that specific genetic influences explained much of the variance in alcohol dependence, leading them to conclude that there is a genetically mediated vulnerability to developing psychopathologies such as PTSD and alcohol or drug dependence.[15]

Engdahl et al.[13] studied psychiatric disorders among 262 male, former prisoners of war (POWs) receiving care at the Minneapolis Veterans Affairs (VA) Medical Center from 1991 to 1994. PTSD and alcohol use disorders were assessed using diagnostic interviews. When considering lifetime history of PTSD and alcohol use disorders, POWs with PTSD were 2.5 times (95% CI: 1.5-4.3) more likely to have an alcohol use disorder than POWs without. Although lifetime PTSD was associated with a significant increase in the risk of lifetime alcohol use disorders, there was no significant association between current PTSD and current alcohol use disorders.[13]

Jakupcak et al.[16] surveyed 287 veterans of Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) at the Seattle Deployment Health Clinic of the VA Puget Sound Health Care System from May, 2004 through January 1, 2007. PTSD was assessed using the PTSD Checklist-Military Version and alcohol abuse was assessed using the Patient Health Questionnaire (PHQ) Alcohol Abuse Subscale. The prevalence of alcohol misuse was 28% and PTSD was 37.3%. Veterans screening positive for alcohol misuse were more likely to be younger and male. Veterans with PTSD were 2.1 times (95% CI: 1.02-4.32) more likely to misuse alcohol than those without PTSD. In addition, when examining the relationship between PTSD symptom clusters and PTSD, they found that only symptoms of emotional numbing were significantly associated with alcohol misuse (OR=1.35; 95% CI: 1.04-1.75).[16]

Green et al.[17] examined PTSD, resilience and functional correlates (including alcohol problems) among 497 veterans that served in OEF and/or OIF since 9/11/01. PTSD, alcohol use and resilience were assessed in clinical interviews that utilized the Davison Trauma Scale, the AUDIT and the Connor-Davidson Resilience Scale (CD-RISC). The AUDIT scores were significantly higher in the group with PTSD compared to those without PTSD ($P<0.001$). Further, using linear regression modeling and adjusting for age, race, gender, resilience, and combat and trauma exposure, the researchers found that AUDIT scores increased with PTSD ($P<0.05$). It is worth noting that resilience was associated with lower AUDIT scores after adjusting for age, race, gender, PTSD, and combat and trauma exposure.[17]

Young Adults

Two studies specifically focused on young adults and were considered for this review (See Table 3.3).[18, 19] Both studies found a significant association between PTSD, which resulted from numerous individual traumatic experiences, and problem drinking.[18, 19] Breslau et al.[18] interviewed 1,007 young adults (ages 21 to 30) selected at random from a health maintenance organization in Detroit. Diagnostic interviews were used to assess both PTSD and alcohol abuse or dependence. They found that the prevalence of having an alcohol use disorder was 1.5 times greater among participants with PTSD compared to those without (31.2% vs. 20.5%). Further, after adjustment for age, the odds of alcohol abuse or dependence was 2.23 times (95% CI: 1.36-3.63) greater among those with PTSD than those without.[18] Further, Danielson et al.[19] evaluated risk factors for substance abuse among 1753 young adults that participated in the 2003-04 follow-up survey to the original National Survey of Adolescents (NSA) in 1995. Substance abuse and PTSD (in the past six months) were assessed using interview questions meeting DSM-IV criteria. Other covariates considered included: sexual assault, physical assault, physical punishment, and witnessing violence. Twenty-five percent of participants met the criteria for alcohol abuse. They found that the odds of alcohol abuse was 2.30 times (95% CI: 1.47-3.60) greater among those with PTSD compared to those without after controlling for age, gender, race and lifetime history of abuse, or violence, and family history of drug or alcohol problems. When stratified by gender, the association was slightly stronger among females (OR: 2.44; 95% CI: 1.36-4.37) than males (OR: 2.11; 95% CI: 1.06-4.20).[19]

Other Studies

Three studies on populations which did not fit into the previous categories were also considered (See Table 3.4).[20-22] All three studies found an association between PTSD and problem drinking.[20-22]

Leeies et al.[21] used a sample population drawn from National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) Wave 2 survey of mental illness in community-dwelling adults. This study is considered representative of civilian, non-institutionalized adult US population. Their study focused on a sub-sample of 2,643 individuals with a lifetime history of PTSD. PTSD was assessed using the Alcohol Use Disorders and Associated Disabilities Interview (AUDADIS-IV). Interestingly, they did not assess alcohol consumption, but instead participants were asked in the PTSD section of the NESARC, "Did you EVER drink alcohol to improve or make yourself feel better when you were having some of these reactions to a stressful event?" Participants were considered to have self-medicated with alcohol if they answered yes. A similar question about drug use was asked to assess self medication with drugs. The study found that 14.4% of individuals with PTSD reported self-medicating with alcohol. Alcohol and drug use were combined when the researchers examined sociodemographic correlates of self medication. Women with PTSD were half as likely as men with PTSD to self medicate their PTSD symptoms (OR=0.39; 95% CI: 0.30-0.52). Individuals over age 65 with PTSD were 68% (OR=0.32; 95% CI: 0.18-0.57) less likely than 20-29 year olds with PTSD to self medicate. Individuals with at least some college education were 1.50 times (95% CI: 1.05-2.15) more likely than those with less than a high school education to self medicate their PTSD symptoms.[21]

Driessen et al.[20] studied the prevalence of PTSD among 459 participants recruited from 14 North German clinical centers, from July 2005 to March 2006, who were seeking treatment and/or counseling for drug and/or alcohol dependence. Participants were categorized as alcohol dependent only (39.7%), drug dependent only (33.6%) or both (26.7%). Among those with alcohol dependence only, the prevalence of PTSD was 15.4%, which was less than the prevalence in either the drug dependent group (29.9%) or the alcohol and drug dependent group (34.1%). More than half (55%) of those with alcohol dependence either had PTSD, subsyndromal PTSD or traumatic exposure. While the prevalence of PTSD according to alcohol use was presented, we recalculated data presented by Driessen to determine the prevalence of alcohol dependence according to PTSD. The prevalence of alcohol dependence was 24.1% among those with PTSD, which was less than the prevalence of alcohol dependence in the group without PTSD, subsyndromal PTSD or traumatic exposure (51.6%).[20]

Peller et al.[22] examined the demographic and clinical characteristics of 729 repeat DUI (Driving Under the Influence) offenders one year after admission to a 2-week in-patient facility of the Middlesex Driving Under the Influence of Liquor Program in Massachusetts. The study was conducted over a one year period from 2005 to 2006. Participants agreed to allow access to their initial assessment for baseline data. Almost all participants qualified as having an alcohol use disorder (97.6%) and more than three-fourths (81.8%) reported at least one lifetime traumatic event. Thirteen percent of the population had lifetime PTSD and 12% had PTSD within the prior year. The past year prevalence of PTSD was significantly higher among women than men and among those with lower income (<$20,000 annually) than those with higher income. The researchers

used logistic regression to model the probability of self-reported DUI recidivism (not actual DUI arrests) among those with PTSD compared to those without. Interestingly, after adjusting for demographic variables associated with both PTSD and DUI recidivism, those with PTSD were 5.12 times (95% CI: 1.21-21.55) more likely to have a self-reported DUI re-offense than those without PTSD.[22]

Discussion

A total of 20 articles on PTSD and problem drinking were included in this review, eighteen of which included some direct assessment of association between PTSD and alcohol use. Eighty-three percent (n=15) of the 18 articles found a positive association between PTSD and problem drinking, and 16% (n=3) found no association between PTSD and problem drinking. The remaining two studies documented a positive association between problem drinking and the events of 9/11 without consideration of the association between PTSD and problem drinking.

The majority of these studies involved participants that were either predominantly or entirely male (68%) and were predominantly white (94%). Less than half of the studies focused on populations within an urban setting.[1, 4-7, 18]None of the studies examined whether there was heterogeneity of the association between PTSD and problem drinking across key demographic characteristics. Only one study, Danielson et al.[19] stratified the analysis by gender, which allowed readers to visually assess whether the association was different for males and females. Danielson found that the association was slightly stronger among females.[19]

Most studies provided useful descriptive statistics on the prevalence of problem drinking. Problem drinking was generally higher among young adults, males, those who were unmarried, had at least some college education and were white. Leeies et al. found that men and young adults were more likely to self medicate.[21] Vlahov et al. found that new onset problem drinking was greater among women than men and Asians compared to other racial/ethnic groups.[1] Four studies found higher levels of problem drinking among those with a greater number of 9/11 experiences or who were in close proximity to the WTC site.[1, 6, 7, 11] Finally, the analysis conducted by Leeis et al.[21]was interesting because it directly assessed the extent to which participants with PTSD reported consuming alcohol to ameliorate their PTSD symptoms (14.4%).

Across the articles reviewed, there were many differences in measurement of outcomes and exposures, study design and statistical methods used. Fifteen of the studies considered alcohol use disorders (alcohol abuse or dependence) as measured by the CAGE questionnaire, AUDADIS, AUDIT or clinical interview.[1, 7-9, 12-22] Three studies focused on alcohol consumption (either increased consumption or consuming more alcohol than intended)[4, 5, 10] and one study considered alcohol use disorders, increased consumption and binge drinking.[6] Only six included alcohol use prior to the traumatic exposure of interest, two of which did not include PTSD.[1, 4, 7-10] By assessing only the presence of an alcohol use disorder, many researchers did not consider groups that were engaged in drinking patterns which could increase their risk of physical and mental health problems, and injury, as well as future development of alcohol abuse or dependence. Furthermore, by not including problem drinking in their analyses the burden of problem alcohol use among those with PTSD may be underestimated. Of the 18 studies that

included PTSD, 16 analyzed PTSD as a dichotomous variable[4-6, 8, 9, 12-14, 16-22] and two examined the association between alcohol use and the presence of PTSD symptoms.[1, 11] Most of the studies were cross-sectional (85%), and only a few of the studies used regression analyses to examine the association, adjusting for other risk factors (varying by study), and the remaining studies considered the association at the bivariate level only. As a result, comparing the results of these studies is difficult for few studies examined the same outcome and the same exposure or used the same measurements.

This review indicates a need for continued research on the risk of problem drinking individuals with PTSD as well as those exposed to major traumatic events, like 9/11, other acts of terrorism or disasters. It is imperative that we identify risk factors for problem drinking, particularly in urban populations, as those residing in urban settings are already at increased risk for traumatic exposures, PTSD and problem drinking. Researchers should focus their attention on studies in multi-racial/ethnic populations using a large sample size. This would allow for more in-depth analyses of interactions between PTSD and selected sociodemographic characteristics as well as peri- and post-trauma experiences, which would provide a more nuanced understanding of the factors which place individuals at heightened risk for problem drinking. Further, it is important that problem drinking be examined in addition to alcohol use disorders. It is imperative to identify not only those with a current alcohol use disorder, but also those at risk for developing one. It is of particular importance to understand these risk factors in the context of an urban setting where as a consequence of high population density, the prevalence of both traumatic exposures and vulnerabilities are high. A better understanding of which groups may have a heightened risk of problem drinking as a

consequence of PTSD or traumatic exposure will create more informed public health policy particularly in the arena of disaster planning and emergency preparedness.

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Table 3.1 Studies Focused on Disaster Exposed Populations					
Authors, Year	**Study Design/Setting**	**Sample Characteristics**	**Trauma Type**	**Post-trauma Period Covered**	**Results**
Vlahov, D. et al. 2006[1]	NYC metropolitan area, computer-assisted telephone interview Cross-sectional	NYC metropolitan area residents (N=1,570) Mean age = 42 Females (60%) White (36%) African American (26%) Hispanic (29%) PTSD (28.4%)	9/11 Terrorist Attacks	Within 1 year of 9/11 (March 2002 – June 2002)	Those with drinking problems after 9/11 were four to five times more likely than those without drinking problems after 9/11 to have PTSD Prevalence of people with drinking problems before 9/11 was 3.7% (95% CI: 2.4-5.1) and 4.2% after 9/11 (95%, CI: 2.8-5.6) Among those who did not report alcohol use prior to 9/11, there was an association between age (less than 25 years), low income, marital status, peri-disaster panic attack, lost possessions, 9/11 job loss and the new onset of drinking problems post-disaster ($p<0.10$). Women more likely than men to report new onset drinking, and Asians were least likely to demonstrate increases in alcohol, compared to other racial/ethnic groups (not statistically significant)
Berninger, A. et al. 2010[4]	Fire Department of NY WTC rescue workforce Data presented as cross-sectional	FDNY firefighters (N=5,656) Majority age 30-49 (86%) Males (100%)	9/11 Terrorist Attacks	Within 6 months of 9/11 (baseline), 3-4 years post-9/11 (follow up)	Increased alcohol use significantly associated with PTSD ($p<0.05$), after adjusting for age, WTC arrival, duration of WTC work, disability retirement, number of deaths in the firehouse, emotional support, decrease exercise,

		White (94%)			counseling, and religious affiliation
Grieger, T.A.. et al. 2003[5]	9/11 survivors from the Pentagon, electronic questionnaire Cross-sectional	Military and civilian staff in one of the Pentagon commands (N=77) Mean age = 37 Males (77%) Whites (81%) PTSD (14%)	9/11 Terrorist Attacks (Pentagon)	Seven months post- 9/11	PTSD group 5.62 times as likely as those without PTSD to report increased alcohol use ($p<0.023$) Women 6.75 times as likely to report increased alcohol use ($p<0.008$)
Boscarino, J.A. et al. 2006[6]	2-wave panel study of English or Spanish speaking adults living in NYC on 9/11 Longitudinal	Random sample of NYC adults W1 (N = 2,368) W2 (N = 1,681) Majority of participants were age 30-44 (33%) or 45-64 (33%) Females (54%) White (43%) African American (26%) Latino (24%) PTSD (4%)	9/11 Terrorist Attacks	1-3 years after 9/11 (W1: October-December 2002, W2: October 2003-February 2004)	No association between PTSD and alcohol consumption, alcohol dependence or binge drinking, after controlling for age, gender, race, education, marital status, lifetime history of traumatic events, history of antisocial behavior, social support, self-esteem and 9/11 experiences Positive association between 9/11 experiences and drinks per month, alcohol dependence at both waves, and drinks per day and binge drinking at W1, after controlling for other risk factors Statistically significant increase in the amount of alcohol consumed post-disaster, and between W1 and W2 ($p<0.001$) Alcohol consumption higher among: those with college-

					education, men, unmarried, white, higher income, those with more 9/11 experiences, and those with higher social support at both W1 and W2, compared to counterparts.
Hasin, D.S. et al. 2007[7]	Community Health Survey originally conducted in 1991-1992; follow-up survey conducted 2002-03 Longitudinal	Sample of drinkers (N=791) ages 18-65 (at index) in a New Jersey county located within 12 miles of lower Manhattan Majority were age 27-35 (28%) Males (54%) White (85%) African American (14%)	9/11 Terrorist Attacks	1-2 years after 9/11	Participants that were within five miles of the WTC on 9/11 were 1.5 times more likely to have an alcohol use disorder 16 weeks after the disaster than those who were more than 5 miles away from the disaster site At 1 week and 16 weeks after 9/11, men consumed more drinks/day than women, those ages 36-41 consumed more drinks/day after 16 weeks Did not examine the association between PTSD and alcohol use
North, C.S. et al. 2010[8]	Oklahoma State Department of Health Public Registry Cross-sectional	Oklahoma City bombing survivors (N=113) Mean age 43 Half male Predominantly White PTSD at 7 years (26%)	Oklahoma City bombing survivors	Seven-year follow up study (November 2001-November 2002)	No association between PTSD and alcohol use disorder after disaster

North, C.S. et al 2010[9]	Merged database of survivors of 10 disasters Cross-sectional	Directly exposed survivors, (N=697) of 10 US disasters or traumatic events Majority were 18-35 (28%) Mean age = 42 Females (57%) White (92%) African American (6%) PTSD (20%)	Indiana hotel-plane crash (1987), Arkansas shooting (1987), Florida tornado (1988), Texas shooting (1991), California earthquake (1994), Missouri shooting (1992), Oklahoma City bombing (1995), Missouri flood (1993), Iowa shooting (1991), California firestorm (1991)	1-6 months and 1-3 years post-disaster	Compared to those without a post-disaster alcohol use disorder, those with a disorder experienced a significantly higher prevalence of disaster-related PTSD (28% vs. 18%, p=.005) PTSD associated with post-disaster alcohol abuse/dependence (p=.02) More men than women met criteria for post-disaster alcohol abuse/dependence (p<.001)
Richman, J.A. et al. 2009[10]	Midwestern urban university 6-wave mail survey Longitudinal	Employees from a Midwestern urban university (W6) (N=1517) Mean age= 51 Mostly female (56%) White (58%)	9/11 Terrorist Attacks	1-4 years after 9/11 (2001, 2002, 2003, 2005)	Association between terrorism-related negative beliefs, workplace stressors, and inadequate social bonds with increased drinking after 9/11 3-way interaction between marital status, terrorism-related negative beliefs, and gender in accounting for increased drinking to intoxication (p<.001) 3-way interaction between having children, terrorism-related negative beliefs, and gender in accounting increased binge drinking (p<.01)
Schiff, M. et al. 2006[11]	Sample of HS students in a large city in northern Israel	Random sample of 10th and 11th grade students (N=960) in	Political Violence	2004 academic year	No association between PTSD and alcohol use disorders after adjusting for other risk factors

	in 2004 Cross-sectional	Haifa, Israel Ages 12-15 (Mean=14) Males (52%) 87.7% born in Israel PTSD Symptoms (81%)			Physical and psychological proximity to the disaster were positively associated with alcohol consumption, when PTSD and depression were controlled for ($p \leq .05$)
Flory, K. et al. 2009[12]	Adult survivors of Hurricane Katrina interviewed in Columbia, SC or New Orleans, LA Cross-sectional	Adult survivors of Hurricane Katrina (N=209) age 18-79 Mean age = 45 Males (52%) White (37%) African-American (57%)	Hurricane Katrina	2-8 months post disaster (October 2005 and May 2006)	One unit increase in IES-R score positively associated with an increase in AUDIT score ($\beta=0.08$, $p<0.05$) 72% reported current alcohol consumption (36% hazardous or harmful drinking), using AUDIT cutoff score (>7)

Table 3.2 Studies Focused on Military Personnel					
Authors, Year	**Study Design/Setting**	**Sample Characteristics**	**Trauma Type**	**Post-trauma Period Covered**	**Results**
Engdahl, B. et al. 1998[13]	National Comorbidity Survey, diagnostic interviews conducted at the Veterans Affair Medical Center in Minneapolis Cross-sectional	American former prisoners of wars (N=262), Median age= 71 All male Almost all White (98.5%) PTSD (53.4%)	World War II and Korean War	48-51 years after the wars (interviews conducted between 1991-1994)	Among PTSD group, odds of alcohol use disorder greater than those without PTSD (OR: 2.5, 95% CI: 1.5-4.3) Lifetime PTSD associated with significantly increased risk of lifetime alcohol abuse/dependence (p<0.0005) No association between current PTSD and current alcohol abuse/dependence
Kulka, R.A. et al. 1990[14]	National Vietnam Veterans Readjustment Study Cross-sectional	Data on alcohol use and PTSD presented for male veterans Current PTSD (15.2%)	Vietnam war	15-20 years after discharge from military service (1986-1987)	Among PTSD group, 11.2% had an alcohol-related disorder 75% of PTSD group had lifetime prevalence of alcohol-related disorder, and 22% with active PTSD also had current alcohol-related disorder
Scherrer, J.F. et al. 2008[15]	Vietnam Era Twin Registry	Cohort of male-male twin pairs born between 1939-1957, that served on active military duty during the Vietnam War era (N=5,312) Mean age= 45 All male Predominantly White (90%)	Vietnam war	12-17 years after the Vietnam war (1987-1992)	Among the PTSD group, the prevalence of alcohol dependence among low, medium, and high combat exposure was 79%, 67% and 67% compared to the prevalence of alcohol dependence among those without PTSD (30%, 36% and 32%) After adjusting for combat level, PTSD was significantly associated with alcohol dependence (OR=3.6; 95% CI: 2.8-4.6)

		PTSD (19%)			
Jakupcak, M. et al. 2010[16]	Seattle Deployment Health Clinic of the VA Puget Sound Health Care System Cross-sectional	Iraq and Afghanistan War veterans (N=287) Demographic characteristics not provided PTSD (37%)	Iraq and Afghanistan Wars	Interviews were conducted from May 2004-Januray 2007 Exact post-deployment time was not provided	Prevalence of alcohol misuse 28% and PTSD 37.3% Veterans who screened positive for alcohol misuse were younger (p=.02), and male (p=.07) PTSD significantly associated with alcohol misuse (OR: 2.10, 95% CI:1.02-4.32) (p≤.05) Symptoms of emotional numbing were significantly associated with alcohol misuse (OR:1.35; 95% CI: 1.04-1.75)
Green, K.T. et al. 2010[17]	Department of Veterans Affairs (VA) Veterans Integrated Service Network Cross-sectional	Veterans (N=497) Mean age= 37 Mostly male (83%), White (52%) PTSD (36%)	Iraq and Afghanistan Wars	June 2005-February 2009	AUDIT scores increased with one unit increase in PTSD score (p<0.05), after adjusting for age, race, gender, resilience, combat, and trauma exposure AUDIT scores significantly higher in the group with PTSD compared to those without PTSD (p<0.001)

Table 3.3 Studies Focused on Young Adults					
Authors, Year	**Study Design/Setting**	**Sample Characteristics**	**Trauma Type**	**Post-trauma Period Covered**	**Results**
Breslau, N. et al 1991[18]	Members of a health maintenance organization in Detroit, Michigan Cross-sectional	Random sample of 21-30 year-old members (N=1007) Median age= 26 Females (61.7%) White (80.7%) PTSD (39.1%)	Any traumatic event (i.e. sudden injury/serious accident, physical assault, witnessing someone get seriously hurt or killed, news of sudden death or injury of close relative or friend, narrow escape, threat to one's life, rape, natural disaster)	Time after trauma varied by interview	Having a drinking problem was a risk factor for exposure to traumatic events was 1.47 (95% CI: 1.12-1.93) Prevalence of alcohol use disorder higher among PTSD group compared to non-PTSD group (31.2% vs. 20.5%) Odds of alcohol abuse or dependence 2.23 greater among PTSD than non-PTSD group (95% CI: 1.36-3.63), after adjusting for age
Danielson, C.K. et al. 2009[19]	National Survey of Adolescents (NSA, 1995) Michigan Cross-sectional	Young adults ages 18-26 that participated in the NSA follow-up survey (N=1753), Mean age= 22, Half male (50.2%) Predominantly White (71%) PTSD (35%)	Sexual/physical assault, physical punishment, witnessing violence	Time after trauma varied by interview	25.2% met criteria for alcohol abuse (31.3% of men vs. 19.1% of women) Odds of alcohol abuse 2.30 times (95% CI: 1.47-3.60) greater among those with PTSD group compared to those without, after controlling for age, gender, race, lifetime history of abuse, or violence, and family history of substance abuse. Odds of alcohol abuse among women with PTSD 2.44 times 95% CI: 1.36-4.37) greater than those without.

					Among men with PTSD the odds alcohol abuse was greater than among men without PTSD (OR:2.11, 95% CI: 1.06-4.20)

Table 3.4 Studies Focused on Other Populations					
Authors, Year	**Study Design/Setting**	**Sample Characteristics**	**Trauma Type**	**Post-trauma Period Covered**	**Results**
Driessen, M. et al. 2008[20]	14 alcohol/drug addiction treatment centers across Germany Cross-sectional	Alcohol and drug dependent subjects ages 15-60 seeking treatment (N=459) Mean age= 37 Male (60%) German (94%) Race/ethnicity not provided PTSD (33.3%)	Type of trauma varied by interview	Time after trauma varied by interview	Prevalence of alcohol-only dependence was 39.7% Among those with alcohol-only dependence, the prevalence of PTSD was 15.4% 55% of those with alcohol dependence had either PTSD, subsyndromal PTSD, or traumatic exposure Prevalence of alcohol dependence among PTSD group (24.1% was less than alcohol prevalence among the groups without PTSD, subsyndromal PTSD, or traumatic exposure

Leeis, M. et al. 2010[21]	National Epidemiologic Survey on Alcohol and Related Conditions Wave 2 survey of mental illness in community-dwelling adults Cross-sectional	Civilian, non-institutionalized adults with PTSD (N=2,643) ages 20-90 Ages 20-44 (43%) Ages 45-64 (44%) Predominantly female (70%) Mainly White (71%)	Type of trauma varied by interview	Time after trauma varied by interview	Prevalence of self-medication with alcohol among PTSD group was 14.4% Women with PTSD were half as likely as men to utilize alcohol to self-medicate PTSD symptoms (OR:0.39, 95% CI:0.30-0.52) Individuals 65 and older were 68% less likely to self medicate with alcohol or drugs than those ages 20-29 (OR:0.32, 95% CI: 0.18-0.57) Black non-Hispanic Americans with PTSD less likely to self-medicate with alcohol or drugs (OR:0.68, 95% CI:0.48-0.96) Individuals with some college education more likely than those with less than a high school educate to self-medicate PTSD symptoms (OR: 1.50, 95% CI: 1.05-2.15)

Peller,A.J. et al. 2010[22]	Middlesex Driving Under the Influence of Liquor Program Cross-sectional	DUI offenders (W1: N=729 W2: N=484) admitted to a 2-week in-patient facility ages 19-77 Mean age 40 Mostly male (81%) Predominantly white (94%) Current PTSD (12%)	Type of trauma varied by interview	Time after trauma varied by interview	Prevalence of alcohol use disorders = 97.6% PTSD group significantly more likely to have a self-reported DUI at W2 than those without PTSD (OR:5.12, 95% CI: 1.21-21.55)

Chapter 4

The Effects of Age, Gender and Race/Ethnicity on the Association between Posttraumatic Stress Disorder and Problem Drinking

Introduction

As shown in Chapter 3, previous studies have demonstrated an association between exposures to psychological trauma and substance abuse, particularly problem drinking.[1-20] Moreover, studies focusing on the consequences of the 9/11 terrorist attacks on problem drinking have been more limited and mostly examined general population samples in NYC[1, 3, 20, 21] or New Jersey[2]. These studies examined the association between PTSD and alcohol while controlling for risk factors.[1-3, 20-23] However, these studies did not examine how these factors affect the association between PTSD and alcohol use. Furthermore, while the majority of studies reviewed in Chapter 3 had participants that were predominantly or entirely male (68%) and were predominantly white (94%), none of these studies examined how age, gender or race/ethnicity affected the association between PTSD and problem drinking. In fact, only one study (Danielson et al.[7]) stratified their analysis by gender. However, the study did not formally test for the heterogeneity of this association according to gender.

To address gaps in the current literature, this study aims to investigate the relationships between PTSD and problem drinking among enrollees in the World Trade Center Health Registry (Registry) before and after controlling for age, gender, race/ethnicity, marital status, education, income, cigarette smoking, history of depression and mode of enrollment in the Registry and to examine whether the strength of this association varies with age, gender and race/ethnicity.

Results

The population for this study was predominantly male (62.4%) and non-Hispanic White (72.7%; Table 4.1). The mean age of the sample was 46.8 (SD=11.3) and most individuals were aged 45 to 64 (50.4%). More than two-thirds (69.6%) were either married or living with a partner. More than half (55.2%) reported having a college or post-graduate education and almost one-third (29.1%) of the population reported a 2002 household income of $100,000 or greater. Most individuals were non-smokers (86.6%). Nearly one-fourth (22.8%) of individuals had ever been diagnosed with depression. Nearly 75% of individuals were self-identified.

Overall, 78% of enrollees reported any alcohol use, with 29% reporting problem drinking (binge drinking only (18.8%), heavy drinking only (2.0%) or both (8.5%) (see Appendix E). The prevalence of problem drinking decreased with increasing age, with 18 to 29 year olds reporting the most problem drinking (P-value <0.0001; Table 4.1). Problem drinking was higher among men, non-Hispanic whites, those who were never married, those with some college, those with higher income, current smokers, those ever diagnosed with depression and those who self enrolled in the Registry compared to their counterparts in each characteristic (P-value <0.0001). Table 4.1 also shows the crude prevalence of alcohol use by PTSD. More than one-third (37%) of individuals with PTSD at Wave 2 reported problem drinking, compared to 28% among those without PTSD at Wave 2.

Prevalence estimates of PTSD are presented in Table 4.2. The prevalence of PTSD at Wave 2 among enrollees in this study was 18.6%. Over 75% of the population did not have PTSD at either Wave of the survey. Almost 10% of the population had late-

onset PTSD and 9.2% had chronic PTSD. The prevalence of PTSD was associated with age, gender, race/ethnicity, marital status, education, income, smoking status, depression and mode of enrollment (all P-values <0.05). The highest prevalence estimates of PTSD were observed among 45 to 64 year olds, women, blacks and Hispanics, enrollees that were divorced, widowed or separated, those with lower income or education level, smokers, those with a history of depression and those who self-enrolled in the Registry.

PTSD and Alcohol Use

Table 4.3 shows the crude and adjusted odds ratio estimates for the association between PTSD and alcohol use. While PTSD and non-problem drinking were associated (OR: 0.55; 95% CI: 0.52-0.60), there was no association between PTSD and problem drinking in the unadjusted analysis. However, after adjustment regardless of the covariates included in the models, a significant increased in the odds of problem drinking was noted among enrollees with PTSD. When compared to enrollees without PTSD in the fully-adjusted model (Model 4), the odds of problem drinking was 19% (OR: 1.19; 95% CI: 1.10-1.28) greater among enrollees with PTSD while the odds of non-problem drinking was 28% (OR: 0.72; 95% CI: 0.67-0.77) lower.

Heterogeneity of the association between PSTD and alcohol use was observed with age (P-value=0.0004), gender (P-value=0.0004) and race/ethnicity (P-value <0.0001; Table 4.4). The association between PTSD and problem alcohol use was significant among those aged 30 to 44 and 45 to 64 years only. Specifically, the odds of problem drinking was 1.17 times (95% CI: 1.03-1.33) and 1.23 times (95% CI: 1.11-1.37) greater among those aged 30 to 44 and 45 to 64 year olds with PTSD compared to

their counterparts without PTSD. For non-problem drinking, the odds was negative for enrollees younger than 65 years of age. However, while a negative effect was also observed for those aged 18-29 years (OR: 0.53; 95% CI: 0.37-0.77), this effect was stronger. While men and women exhibited the same pattern for non-problem and problem drinking among those with PSTD, the associations for non-problem and problem drinking were slightly stronger for men than for women. Finally, Asians with PTSD exhibited an odds of problem drinking 1.73 times (95% CI: 1.17-2.56) greater than their counterparts without PTSD. The odds of problem drinking for enrollees with PTSD was also significantly greater for blacks (OR: 1.38; 95% CI: 1.06-1.80) and Hispanics (OR: 1.41; 95% CI: 1.15-1.73). For those self-identified as multiracial or other race, the estimate for problem drinking was 1.62 (95% CI: 1.06-2.46). Interestingly, among non-Hispanic whites and Hispanics, the odds of non-problem drinking was 32% (OR: 0.68; 95% CI: 0.62-0.75 for whites and OR: 0.68; 95% CI: 0.56-82 for Hispanics) lower for those with PSTD compared to those without PTSD.

PTSD Trajectory and Alcohol Use

Crude and adjusted odds ratios were also estimated for the association between PTSD trajectory and alcohol use (See Appendix F). Enrollees with late-onset PTSD reported more problem drinking than those with chronic, resolved or no PTSD (39%, 35%, 26% and 28% respectively). The odds of problem drinking was 24% greater among enrollees with late-onset PTSD compared to those without PTSD (OR: 1.24; 95% CI: 1.14-1.36). After adjustment for all covariates, when compared to enrollees without PTSD, the odds of problem drinking was 17% (OR: 1.17; 95% CI: 1.05-1.30) greater

while the odds of non-problem drinking was 32% (OR: 0.68; 95% CI: 0.62-0.75) lower among enrollees with chronic PTSD. Interestingly, when compared to enrollees without PTSD, the odds of problem drinking was 21% (OR: 1.21; 95% CI: 1.10-1.34) greater, while the odds of non-problem drinking was 26% (OR: 0.74; 95% CI: 0.68-0.82) lower among enrollees with late-onset PTSD.

Discussion

This study found a high prevalence of both PTSD and alcohol use among Registry enrollees. More than three-fourths of enrollees reported any alcohol use and 29% reported problem drinking. This prevalence is higher than the 16.9% reported in the 2007 NYC Community Health Survey (CHS).[24] Furthermore, among individuals with PTSD the prevalence of problem drinking (37%) was more than twice as high as the prevalence from the 2007 CHS.[24] Almost 20% of enrollees had PTSD at the time of the second survey, which is more than twice the lifetime prevalence of PTSD in the US of less than 10%.[25-29]

In the fully-adjusted model, we found a significant positive association between PTSD and problem drinking while the opposite was true for the association between PTSD and non-problem drinking. Specifically, enrollees with PTSD are more likely to be problem drinkers than non-drinkers and more likely to be non-drinkers than non-problem drinkers. Finally, the strength of the association between PTSD and alcohol use differed with age, gender and race/ethnicity, with those aged 45-64, men and Asians exhibiting the strongest positive associations for problem drinking. However, the associations

between PTSD and non-problem drinking remained negative regardless of age, gender or race/ethnicity.

Consistent with previous studies among those with traumatic exposure(s), we found that the prevalence of problem drinking was significantly greater among men[1, 2, 14, 19], non-Hispanic Whites[1], young adults[14, 20], those unmarried[1], those with higher income[1] and those with PTSD.[1, 4, 6-15, 20, 23, 30, 31] However, when the association between PTSD and problem drinking was examined, we found non-significant associations for some of the groups. For example, although young adults aged 18-29 had the highest rate of problem drinking, the association between PTSD and problem drinking was not significant. Men were more likely to problem drink than women (34.0% vs. 21.6%). Moreover, when controlling for all covariates, the association between PTSD and alcohol use was similar for men and women. Interestingly, Danielson et al.[7] found that the association between PTSD and alcohol use was slightly stronger for women than men. However, this study did not formally examine for heterogeneity of the association between PTSD and alcohol use according to gender. Finally, our findings suggest that Asians who were least likely to report problem drinking had an almost two-fold increase in the probability of drinking when they had PTSD. This finding is consistent with Vlahov et al. post-9/11.[20] Although not statistically significant, Vlahov et al. found that new onset problem drinking was greater among Asians compared to other racial/ethnic groups.[20]

We found a significant association between PTSD and problem drinking after adjusting for selected covariates. Moreover, this association varies with age, gender and race/ethnicity. Specifically, our findings make a significant contribution to the current

literature by demonstrating that problem drinking was stronger for those aged 30-44 and 45-64, men, non-Hispanic blacks, Hispanics/Latinos, Asians and those categorized as multiracial/other with PTSD when compared to their counterparts without PTSD. We have underscored that this association was stronger among groups with lower prevalence of problem drinking, and therefore, may be at higher risk for drinking problems after exposure to a traumatic event than their counterparts who exhibited a higher prevalence of drinking problems.

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Table 4.1. Prevalence of Alcohol Use by Selected Demographic Characteristics Among Adult Enrollees in the World Trade Center Health Registry, 2006-07

		Alcohol Use in the Last 30 Days			
		No Alcohol Use	Non-Problem Drinking	Problem Drinking	
	N (%)	N (%)	N (%)	N (%)	P-value*
Overall	38302	8445 (22.1)	18626 (48.6)	11231 (29.3)	
Demographic Characteristics					
Age at Wave Two (years)					
18-29	2213 (5.8)	288 (13.0)	907 (41.0)	1018 (46.0)	<0.0001
30-44	14533 (37.9)	2691 (18.5)	6684 (46.0)	5158 (35.5)	
45-64	19288 (50.4)	4656 (24.1)	9830 (51.0)	4802 (24.9)	
65+	2268 (5.9)	810 (35.7)	1205 (53.1)	253 (11.2)	
Gender					
Male	23915 (62.4)	4638 (19.4)	11153 (46.6)	8124 (34.0)	<0.0001
Female	14387 (37.6)	3807 (26.5)	7473 (51.9)	3107 (21.6)	
Race/Ethnicity					
Non-Hispanic White	27850 (72.7)	5287 (19.0)	13744 (49.4)	8819 (31.7)	<0.0001
Non-Hispanic Black	3461 (9.0)	1113 (32.2)	1715 (49.6)	633 (18.3)	
Hispanic or Latino	4120 (10.8)	1135 (27.6)	1814 (44.0)	1171 (28.4)	
Asian	1806 (4.7)	641 (35.5)	845 (46.8)	320 (17.7)	
Multiracial/Other	1065 (2.8)	269 (25.3)	508 (47.7)	288 (27.0)	
Marital Status					
Married/Living with Partner	26673 (69.6)	5693 (21.3)	13229 (49.6)	7751 (29.1)	<0.0001
Divorced/Separated/Widowed	5122 (13.4)	1432 (28.0)	2354 (46.0)	1336 (26.1)	
Never married	6507 (17.0)	1320 (20.3)	3043 (46.8)	2144 (33.0)	
Education					
College/Post Graduate	21151 (55.2)	3766 (17.8)	11380 (53.8)	6005 (28.4)	<0.0001
Some College	9475 (24.7)	2274 (24.0)	4232 (44.7)	2969 (31.3)	
HS Graduate/GED	6709 (17.5)	2004 (29.9)	2697 (40.2)	2008 (29.9)	
Less than HS	967 (2.5)	401 (41.5)	317 (32.8)	249 (25.8)	

	N (%)	No Alcohol Use N (%)	Non-Problem Drinking* N (%)	Problem Drinking** N (%)	P-value*
2002 Household Income					
≥ 100,000	11127 (29.1)	1539 (13.8)	5960 (53.6)	3628 (32.6)	<0.0001
75,000-99,999	7158 (18.7)	1415 (19.8)	3467 (48.4)	2276 (31.8)	
$50,000-74,999	7624 (19.9)	1790 (23.5)	3602 (47.3)	2232 (29.3)	
$25,000-49,999	6427 (16.8)	2073 (32.3)	2742 (42.7)	1612 (25.1)	
Missing	3401 (8.9)	740 (21.8)	1913 (56.3)	748 (22.0)	
≤ $24,999	2565 (6.7)	888 (34.6)	942 (36.7)	735 (28.7)	
Tobacco Use At Wave Two					
Yes	5137 (13.4)	983 (19.1)	1847 (36.0)	2307 (44.9)	<0.0001
No	33165 (86.6)	7462 (22.5)	16779 (50.6)	8924 (26.9)	
Ever Diagnosed with Depression					
Yes	8746 (22.8)	2229 (25.5)	3685 (42.1)	2832 (32.4)	<0.0001
No	29556 (77.2)	6216 (21.0)	14941 (50.6)	8399 (28.4)	
PTSD at Wave 2					
Yes	7139 (18.6)	1908 (26.7)	2593 (36.3)	2638 (37.0)	<0.0001
No	31163 (81.4)	6537 (21.0)	16033 (51.5)	8593 (27.6)	
PTSD Group					
Chronic (W1+, W2+)	3520 (9.2)	1063 (30.2)	1228 (34.9)	1229 (34.9)	<0.0001
Late Onset	3619 (9.5)	845 (23.4)	1365 (37.7)	1409 (38.9)	
Resolved	1700 (4.4)	454 (26.7)	802 (47.2)	444 (26.1)	
No PTSD	29463 (76.9)	6083 (20.7)	15231 (51.7)	8149 (27.7)	
Enrollment					
List-Identified	9653 (25.2)	2438 (6.4)	4624 (47.9)	2591 (26.8)	<0.0001
Self-Identified	28649 (74.8)	6007 (21.0)	14002 (48.9)	8640 (30.2)	

*P-values are for chi-square of independence.

Table 4.2. Prevalence of Posttraumatic Stress Disorder by Selected Demographic Characteristics Among Adult Enrollees in the World Trade Center Health Registry, 2006-07

		Probable PTSD at Wave Two			PTSD Group at Wave Two				
		Yes	No		Chronic	Late Onset	Resolved	No PTSD	
	N (%)	N (%)	N (%)	P-value	N (%)	N (%)			P-value
Overall	38302	7139 (18.6)	31163 (81.4)		3520 (9.2)	3619 (9.5)	1700 (4.4)	29463 (76.9)	
Demographic Characteristics									
Age at Wave Two (years)									
18-29	2213 (5.8)	351 (15.9)	1862 (84.1)	<0.0001	138 (6.2)	213 (9.6)	81 (3.7)	1781 (80.5)	<0.0001
30-44	14533 (37.9)	2693 (18.5)	11840 (81.5)		1239 (8.5)	1454 (10.0)	603 (4.2)	11237 (77.3)	
45-64	19288 (50.4)	3839 (19.9)	15449 (80.1)		2002 (10.4)	1837 (9.5)	912 (4.7)	14537 (75.4)	
65+	2268 (5.9)	256 (11.3)	2012 (88.7)		141 (6.2)	115 (5.1)	104 (4.6)	1908 (84.1)	
Gender									
Male	23915 (62.4)	4295 (18.0)	19620 (82.0)	<0.0001	1878 (7.9)	2417 (10.1)	836 (3.5)	18784 (78.5)	<0.0001
Female	14387 (37.6)	2844 (19.8)	11543 (80.2)		1642 (11.4)	1202 (8.4)	864 (6.0)	10679 (74.2)	
Race/Ethnicity									
Non-Hispanic White	27850 (72.7)	4560 (16.4)	23290 (83.6)	<0.0001	1977 (7.1)	2583 (9.3)	910 (3.3)	22380 (80.4)	<0.0001
Non-Hispanic Black	3461 (9.0)	751 (21.7)	2710 (78.3)		467 (13.5)	284 (8.2)	308 (8.9)	2402 (69.4)	
Hispanic or Latino	4120 (10.8)	1242 (30.2)	2878 (69.9)		757 (18.4)	485 (11.8)	321 (7.8)	2557 (62.1)	
Asian	1806 (4.7)	302 (16.7)	1504 (83.3)		153 (8.5)	149 (8.3)	95 (5.3)	1409 (78.0)	
Multiracial/Other	1065 (2.8)	284 (26.8)	781 (73.3)		166 (15.6)	118 (11.1)	66 (6.2)	715 (67.1)	

		Probable PTSD at Wave Two			PTSD Group at Wave Two				
		Yes	No		Chronic	Late Onset	Resolved	No PTSD	
	N (%)	N (%)	N (%)	P-value	N (%)	N (%)			P-value
Marital Status									
Married/Living with Partner	26673	4516	22157	<0.0001	2082	2434	1048	21109	<0.0001
	(69.6)	(16.9)	(83.1)		(7.8)	(9.1)	(3.9)	(79.1)	
Divorced/Separated/Widowed	5122	1432	3690		847	585	337	3353	
	(13.4)	(28.0)	(72.0)		(16.5)	(11.4)	(6.6)	(65.5)	
Never married	6507	1191	5316		591	600	315	5001	
	(17.0)	(18.3)	(81.7)		(9.1)	(9.2)	(4.8)	(76.9)	
Education									
College/Post Graduate	21151	3065	18086	<0.0001	1390	1675	799	17287	<0.0001
	(55.2)	(14.5)	(85.5)		(6.6)	(7.9)	(3.8)	(81.7)	
Some College	9475	2070	7405		1036	1034	432	6973	
	(24.7)	(21.9)	(78.2)		(10.9)	(10.9)	(4.6)	(73.6)	
HS Graduate/GED	6709	1672	5037		885	787	376	4661	
	(17.5)	(24.9)	(75.1)		(13.2)	(11.7)	(5.6)	(69.5)	
Less than HS	967	332	635		209	123	93	542	
	(2.5)	(34.3)	(65.7)		(21.6)	(12.7)	(9.6)	(56.1)	
2002 Household Income									
$\geq$ 100,000	11127	1526	9601	<0.0001	612	914	315	9286	<0.0001
	(29.1)	(13.7)	(86.3)		(5.5)	(8.2)	(2.8)	(83.5)	
75,000-99,999	7158	1286	5872		527	759	254	5618	
	(18.7)	(18.0)	(82.0)		(7.4)	(10.6)	(3.6)	(78.5)	
$50,000-74,999	7624	1478	6146		703	775	386	5760	
	(19.9)	(19.4)	(80.6)		(9.2)	(10.2)	(5.1)	(75.6)	
$25,000-49,999	6427	1546	4881		892	654	433	4448	
	(16.8)	(24.1)	(76.0)		(13.9)	(10.2)	(6.7)	(69.2)	
Missing	3401	476	2925		218	258	131	2794	
	(8.9)	(14.0)	(86.0)		(6.4)	(7.6)	(3.9)	(82.2)	
$\leq$ $24,999	2565	827	1738		568	259	181	1557	
	(6.7)	(32.2)	(67.8)		(22.1)	(10.1)	(7.1)	(60.7)	

		Probable PTSD at Wave Two			PTSD Group at Wave Two				
		Yes	No		Chronic	Late Onset	Resolved	No PTSD	
	N (%)	N (%)	N (%)	P-value	N (%)	N (%)			P-value
Tobacco Use At Wave Two									
Yes	5137 (13.4)	1586 (30.9)	3551 (69.1)	<0.0001	815 (15.9)	771 (15.0)	294 (5.7)	3257 (63.4)	<0.0001
No	33165 (86.6)	5553 (16.7)	27612 (83.3)		2705 (8.2)	2848 (8.6)	1406 (4.2)	26206 (79.0)	
Ever Diagnosed with Depression									
Yes	8746 (22.8)	3925 (44.9)	4821 (55.1)	<0.0001	2290 (26.2)	1635 (18.7)	577 (6.6)	4244 (48.5)	<0.0001
No	29556 (77.2)	3214 (10.9)	26342 (89.1)		1230 (4.2)	1984 (6.7)	1123 (3.8)	25219 (85.3)	
Alcohol Use in the Last 30 Days									
Problem Drinking	11231 (29.3)	2638 (23.5)	8593 (76.5)	<0.0001	1229 (10.9)	1409 (12.6)	444 (4.0)	8149 (72.6)	<0.0001
Non-Problem Drinking	18626 (48.6)	2593 (13.9)	16033 (86.1)		1228 (6.6)	1365 (7.3)	802 (4.3)	15231 (81.8)	
No Alcohol Use	8445 (22.1)	1908 (22.6)	6537 (77.4)		1063 (12.6)	845 (10.0)	454 (5.4)	6083 (72.0)	
Enrollment									
List-Identified	9653 (25.2)	1316 (13.6)	8337 (86.4)	<0.0001	604 (6.3)	712 (7.4)	344 (3.6)	7993 (82.8)	<0.0001
Self-Identified	28649 (74.8)	5823 (20.3)	22826 (79.7)		2916 (10.2)	2907 (10.2)	1356 (4.7)	21470 (74.9)	

*P-values are for chi-square of independence.

Table 4.3. PTSD at Wave Two and Drinking (Odds Ratios and 95% Confidence Intervals)*, Models 1 to 4

	Model 1	Model 2	Model 3	Model 4
PTSD at Wave Two				
No	1.00	1.00	1.00	1.00
Yes-Non-Problem Drinking	0.55 (0.52-0.60)	0.58 (0.54-0.62)	0.68 (0.63-0.72)	0.72 (0.67-0.77)
Yes-Problem Drinking	1.05 (0.98-1.13)	1.15 (1.07-1.23)	1.27 (1.18-1.36)	1.19 (1.10-1.28)

*Model 1: unadjusted; Model 2: adjusted for: age, gender, and race/ethnicity; Model 3: additionally adjusted for income, marital status, education, depression, and smoking; and Model 4: additionally adjusted for mode of enrollment

Table 4.4. PTSD at Wave Two and Drinking (Odds Ratios and 95% Confidence Intervals)*, by Age, Gender and Race/Ethnicity

	Age Group at Wave Two			
	18-29	**30-44**	**45-64**	**65+**
PTSD at Wave Two				
No	1.00	1.00	1.00	1.00
Yes-Non-Problem Drinking	0.53 (0.37-0.77)	0.74 (0.66-0.85)	0.70 (0.64-0.78)	0.88 (0.63-1.23)
Yes-Problem Drinking	0.74 (0.51-1.08)	1.17 (1.03-1.33)	1.23 (1.11-1.37)	1.23 (0.78-1.96)

	Gender	
	Male	**Female**
PTSD at Wave Two		
No	1.00	1.00
Yes-Non-Problem Drinking	0.67 (0.60-0.74)	0.80 (0.71-0.89)
Yes-Problem Drinking	1.21 (1.09-1.34)	1.15 (1.01-1.31)

	Race/Ethnicity				
	White (NH)	**Black (NH)**	**Hispanic/ Latino**	**Asian**	**Multiracial/ Other**
PTSD at Wave Two					
No	1.00	1.00	1.00	1.00	1.00
Yes-Non-Problem Drinking	0.68 (0.62-0.75)	0.96 (0.77-1.18)	0.68 (0.56-0.82)	0.78 (0.56-1.08)	0.70 (0.47-1.04)
Yes-Problem Drinking	1.06 (0.96-1.17)	1.38 (1.06-1.80)	1.41 (1.15-1.73)	1.73 (1.17-2.56)	1.62 (1.06-2.46)

*adjusted for income, marital status, education, depression, smoking and mode of enrollment. In addition, the estimates for age were adjusted for age (continuous), gender and race/ethnicity; the one for gender for age and race/ethnicity; and the one for race/ethnicity for age and gender.

Chapter 5

The Effects of Peri- and Post-Disaster Experiences on the Association between Posttraumatic Stress Disorder and Problem Drinking

Introduction

Previous studies focusing on post-9/11 alcohol use examined the association between traumatic experiences and different forms of alcohol consumption and problem drinking or include these experiences as covariates when examining the association between PTSD and alcohol use.[1-17] However, these studies do not examine how these factors affect the association between PTSD and alcohol use. Of the studies reviewed in Chapter 3, six considered level of combat exposure or specific 9/11-related experiences during their analyses.[2, 3, 16-19] Vlahov et al. found that new onset problem drinking was significantly greater among individuals who had a peri-disaster panic attack, lost possessions or a job as a result of 9/11.[17] While the associations were not significant, their findings also suggest that persons directly affected by the attack (present in the buildings, injured in the attack, lost a loved one, lost possessions, or involved in rescue and recovery work) were more likely to report new onset problem drinking than those not directly exposed.[17] In contrast, Boscarino et al. found no association between PTSD and problem drinking after adjusting for all covariates including 9/11 experiences but found that post-9/11 alcohol consumption was higher among those with more 9/11 experiences and higher social support.[2] The association with 9/11 experiences and problem drinking was significant before and after adjustment for other covariates.[2] Two studies found a significant association of the proximity to the WTC and acts of terrorism with problem drinking.[3, 16] Lastly, in two of the military studies, the association between PTSD and problem drinking remained after adjustment for level of combat exposure.[18, 19]

Although these studies considered the effects of specific traumatic experiences on the association between PTSD and problem drinking none comprised a study population

entirely of individuals directly exposed to the disaster.[2, 3, 16-19] Therefore to address gaps in the current literature, this study aims to investigate whether the relationship between PTSD and problem drinking among enrollees in the World Trade Center Health Registry (Registry) varies according to peri- and post-disaster experiences before and after controlling for age, gender, race/ethnicity, marital status, education, income, cigarette smoking, history of depression and mode of enrollment in the Registry.

Results

Distributions of peri- and post-disaster experiences by alcohol use can be found in Table 5.1. More than half of the enrollees in this study were caught in the dust cloud (51.8%), witnessed tragedy (52.5%), were afraid of being injured or killed (54.4%), or lost a loved one (58.2%) on 9/11. Almost half (47.2%) participated in rescue and recovery activities. Sustaining an injury was only reported by 13.1% of enrollees, only 10.8% of enrollees were displaced from their homes and less than 10% lost their job as a result of 9/11. The mean number of experiences was 2.96 (SD=1.5). Cumulatively, most enrollees either reported one to two (40.0%) or 3 to 4 (42.1%) peri-disaster experiences. More than half of the enrollees reported low social support (51.3%) and less than one-fourth had seen a mental health provider in the last 12 months (21.0%).

The prevalence estimates for non-problem and problem drinking were at least 40% and 30%, respectively, across the eight peri-disaster experiences. Moreover, the prevalence of problem drinking increased as the number of peri-disaster experiences increased. The prevalence of problem drinking was higher among those with low social support compared to those with high social support. Among the different peri-disaster

experiences, enrollees who sustained an injury (34.3%) or lost a loved one on 9/11 (33.1%) had the highest prevalence of problem drinking.

Distributions of peri- and post-disaster experiences by PTSD can be found in Table 5.2. As in the case of problem drinking, the prevalence of PTSD increased with an increasing number of cumulative peri-disaster experiences and was higher among enrollees with low social support compared to those with high social support. Among the different experience variables, enrollees who sustained an injury (37.7%) or lost their job because of 9/11 (47.1%) had the highest prevalence of PTSD. More than half (55.5%) of enrollees with seven to eight peri-disaster experiences had chronic PTSD.

PTSD and Alcohol Use

Table 5.3 shows the crude and adjusted odds ratio estimates for the association between PTSD and alcohol use. While PTSD and non-problem drinking were associated (OR: 0.55; 95% CI: 0.52-0.60), there was no association between PTSD and problem drinking in the unadjusted analysis. However, after adjustment for all sociodemographic covariates (Model 4), a significant increased odds of problem drinking was noted among enrollees with PTSD. In Model 4, when compared to enrollees without PTSD, the odds of problem drinking was 19% (OR: 1.19; 95% CI: 1.10-1.28) greater while the odds of non-problem drinking was 28% (OR: 0.72; 95% CI: 0.67-0.77) lower among enrollees with PTSD. Subsequently, after adjustment for both peri- and post-disaster experiences (Model 10), the association between PTSD and problem drinking was no longer statistically significant. However, the odds ratio for PTSD and non-problem drinking remained significant. Compared to enrollees without PTSD the odds of non-problem drinking

among those with PTSD was 30% (OR: 0.70; 95% CI: 0.65-0.76) lower. It is worth noting that the association between PTSD and alcohol use remained significant regardless of the peri- and/or post-disaster experiences included in the model (Model 5 to 9).

Heterogeneity of the association between PSTD and alcohol use was observed with peri-disaster experience group (P-value=0.0233), social support (P-value=0.0002) and mental health care utilization (P-value <0.0001; Table 5.4). Although there was a statistical interaction, when stratified by experience group, no meaningful pattern was found for the association between PTSD and alcohol use. Therefore, the strata-specific odds ratios were not reported. Enrollees with high social support and PTSD exhibited an odds of problem drinking 25% (OR: 1.25; 95% CI: 1.09-1.43) greater than those with high social support and no PTSD. The odds of non-problem drinking was lower among enrollees with PTSD compared to those without PTSD regardless whether social support was high (OR: 0.77; 95% CI: 0.68-0.87) or low (OR: 0.67; 95% CI: 0.61-0.74). Among enrollees who had not seen a mental health provider, the odds of problem drinking was 25% (OR: 1.25; 95% CI: 1.13-1.38) greater among those with PTSD compared to those without PTSD. The odds of non-problem drinking was lower among enrollees with PTSD compared to those without PTSD whether they had seen a mental health provider (OR: 0.65; 95% CI: 0.57-0.75) or not (OR: 0.77; 95% CI: 0.69-0.84).

PTSD Trajectory and Alcohol Use

Crude and adjusted odds ratios were also estimated for the association between PTSD trajectory and alcohol use (Appendix F). In the unadjusted analysis, the odds of problem drinking was 24% greater among enrollees with late-onset PTSD compared to

those without PTSD (OR: 1.24; 95%CI: 1.14-1.36). The relationship between chronic PTSD and problem drinking was not significant. After adjustment for all covariates, including peri- and post-disaster experiences, when compared to enrollees without PTSD, the odds of problem drinking was 12% (OR: 1.12; 95% CI: 1.01-1.24) greater among enrollees with late-onset PTSD while the odds of non-problem drinking was 27% (OR: 0.73; 95% CI: 0.66-0.80) lower. Interestingly, when compared to enrollees without PTSD, the odds of non-problem drinking was 34% (OR: 0.66; 95% CI: 0.60-0.73) lower among enrollees with chronic PTSD, while there was no association for problem drinking.

Discussion

After adjustment for all sociodemographic characteristics, we found that PTSD was significantly associated with an increased odds of problem drinking and a decreased odds of non-problem drinking. However, after adjusting for peri- and post-disaster experiences, the association between PTSD and problem drinking was no longer significant, while the association between PTSD and non-problem drinking remained significant. Moreover, the association between PTSD and alcohol use differed with level of social support and having a mental health provider. Specifically, among enrollees with high social support, those with PTSD were more likely to problem drink than those without. Among those without a mental health provider, those with PTSD were more likely to problem drink than those without PTSD.

Consistent with previous studies[2, 17], we found that the prevalence of problem drinking was significantly higher among those enrollees with a greater number of peri-

disaster experiences. Previous studies [2, 16, 17, 19] found that the prevalence of problem drinking was higher among those with more 9/11 experiences, greater proximity to the WTC site or acts of terrorism[3, 16] or increased levels of combat exposure[19]. We found a marginally significant association between PTSD and problem drinking after adjustment for all covariates, including peri- and post-disaster experiences. Our findings are in tune with Boscarino et al.[2], who found no association between PTSD and alcohol after controlling for factors (age, gender, race, education, marital status , lifetime history of traumatic events, history of antisocial behavior, social support, and self-esteem). The slight difference in findings between our study and Boscarino et al. may be attributable to the differences in covariates adjusted for in Boscarino et al.'s study (e.g., lifetime history of trauma and antisocial behavior and self-esteem.)

Although the association between PTSD and problem drinking was only marginally significant, when the effect of social support was considered, we found that high social support was significantly associated with problem drinking among enrollees with PTSD compared to those without. However although the prevalence of problem drinking was greater among those with low social support, problem drinking's association with PTSD was not significant among this group. This finding suggests that problem drinking in enrollees with low social support is driven by factors other than PTSD, while among those with high social support, problem drinking is driven by, in part, PTSD. It is also possible that those with high social support may be more inclined to use alcohol as a coping strategy or as a form of self-medication based on group norms and social acceptability.

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Table 5.1. Prevalence of Alcohol Use by Peri- and Post Disaster Experiences Among Adult Enrollees in the World Trade Center Health Registry, 2006-07

		Alcohol Use in the Last 30 Days			
	Total	**No Drinking**	**Non-Problem Drinking**	**Problem Drinking**	**P-value***
	N (%)	**N (%)**	**N (%)**	**N (%)**	
Peri-Disaster Experiences					
Caught in the Dust Cloud on 9/11	19843 (51.8)	4232 (21.3)	9607 (48.4)	6004 (30.3)	<0.0001
Witnessed Tragedy on 9/11[†]	20094 (52.5)	4180 (20.8)	9834 (48.9)	6080 (30.3)	<0.0001
Afraid of Injury or Death on 9/11	20841 (54.4)	4303 (20.7)	10025 (48.1)	6513 (31.3)	<0.0001
Sustained an Injury on 9/11[‡]	5033 (13.1)	1151 (22.9)	2158 (42.9)	1724 (34.3)	<0.0001
Bereavement as a result of 9/11	22286 (58.2)	4400 (19.7)	10521 (47.2)	7365 (33.1)	<0.0001
Displaced from Home[§]	4164 (10.8)	573 (13.8)	2239 (53.8)	1352 (32.5)	<0.0001
Worked in Rescue/Recovery	18095 (47.2)	4252 (23.5)	8085 (44.7)	5758 (31.8)	<0.0001
9/11-Related Job Loss or Unemployment	2905 (7.6)	767 (26.4)	1201 (41.3)	937 (32.3)	<0.0001
Total Number of Peri-Disaster Experiences					
0	646 (1.7)	178 (27.6)	350 (54.2)	118 (18.3)	<0.0001
1 - 2	15307 (40.0)	3643 (23.8)	7724 (50.5)	3940 (25.7)	
3 - 4	16106 (42.1)	3324 (20.6)	7872 (48.9)	4910 (30.5)	
5 - 6	5987 (15.6)	1239 (20.7)	2584 (43.2)	2164 (36.1)	
7 - 8	256 (0.7)	61 (23.8)	96 (37.5)	99 (38.7)	
Mean, SD	2.96 (1.5)				

		Alcohol Use in the Last 30 Days			
	Total	**No Drinking**	**Non-Problem Drinking**	**Problem Drinking**	**P-value***
	N (%)	**N (%)**	**N (%)**	**N (%)**	
Post-Disaster Experiences					
Social Support					
High	18652 (48.7)	4233 (22.7)	9524 (51.1)	4895 (26.2)	<0.0001
Low	19650 (51.3)	4212 (21.4)	9102 (46.3)	6336 (32.2)	
Saw a Mental Health Professional in the last 12 months	8056 (21.0)	1959 (24.3)	3572 (44.3)	2525 (31.3)	<0.0001

*P-values are for chi-square of independence.

† having witnessed at least one of the following events: an airplane hitting the WTC, people falling or jumping from the WTC, buildings collapsing, people running away from the dust cloud or smoke and other people being injured or killed

‡ reporting at least one of the following injuries sustained on 9/11: burns, cuts/abrasions/puncture wounds, sprain/strain, fractured or dislocated bones and head injury)

§ displaced from home for at least 24 hours between 9/11/01 and 9/18/01

Table 5.2. Prevalence of Posttraumatic Stress Disorder by Peri- and Post Disaster Experiences Among Adult Enrollees in the World Trade Center Health Registry, 2006-07

		Probable PTSD at Wave Two			PTSD Group at Wave Two				
		Yes	No		Chronic	Late Onset	Resolved	No PTSD	
Peri-Disaster Experiences									
Caught in the Dust Cloud on 9/11	19843 (51.8)	4744 (23.9)	15099 (76.1)	<0.0001	2545 (12.8)	2199 (11.1)	1115 (5.6)	13984 (70.5)	<0.0001
Witnessed Tragedy on 9/11[†]	20094 (52.5)	4720 (23.5)	15374 (76.5)	<0.0001	2538 (12.6)	2182 (10.9)	1132 (5.6)	14242 (70.9)	<0.0001
Afraid of Injury or Death on 9/11	20841 (54.4)	5376 (25.8)	15465 (74.2)	<0.0001	2858 (13.7)	2518 (12.1)	1224 (5.9)	14241 (68.3)	<0.0001
Sustained an Injury on 9/11[‡]	5033 (13.1)	1895 (37.7)	3138 (62.4)	<0.0001	1164 (23.1)	731 (14.5)	364 (7.2)	2774 (55.1)	<0.0001
Bereavement as a result of 9/11	22286 (58.2)	5144 (23.1)	17142 (76.9)	<0.0001	2572 (11.5)	2572 (11.5)	1030 (4.6)	16112 (72.3)	<0.0001
Displaced from Home [§]	4164 (10.9)	653 (15.7)	3511 (84.3)	<0.0001	331 (8.0)	322 (7.7)	172 (4.1)	3339 (80.2)	<0.0001
Worked in Rescue/Recovery	18095 (47.2)	3449 (19.1)	14646 (80.9)	0.0449	1498 (8.3)	1951 (10.8)	605 (3.3)	14041 (77.6)	<0.0001
9/11-Related Job Loss or Unemployment	2905 (7.6)	1369 (47.1)	1536 (52.9)	<0.0001	924 (31.8)	445 (15.3)	208 (7.2)	1328 (45.7)	<0.0001
Total Number of Peri-Disaster Experiences									
0	646 (1.7)	26 (4.0)	620 (96.0)	<0.0001	11 (1.7)	15 (2.3)	23 (3.6)	597 (92.4)	<0.0001
1 to 2	15307 (40.0)	1421 (9.3)	13886 (90.7)		515 (3.4)	906 (5.9)	415 (2.7)	13471 (88.0)	
3 to 4	16106 (42.1)	3242 (20.1)	12864 (79.9)		1553 (9.6)	1689 (10.5)	885 (5.5)	11979 (74.4)	
5 to 6	5987 (15.6)	2279 (38.1)	3708 (61.9)		1299 (21.7)	980 (16.4)	367 (6.1)	3341 (55.8)	
7 to 8	256 (0.7)	171 (66.8)	85 (33.2)		142 (55.5)	29 (11.3)	10 (3.9)	75 (29.3)	

		Probable PTSD at Wave Two			PTSD Group at Wave Two				
Post-Disaster Experiences		**Yes**	**No**		**Chronic**	**Late Onset**	**Resolved**	**No PTSD**	
Social Support									
High	18652 (48.7)	2447 (13.1)	16205 (86.9)	<0.0001	1138 (6.1)	1309 (7.0)	738 (4.0)	15467 (82.9)	<0.0001
Low	19650 (51.3)	4692 (23.9)	14958 (76.1)		2382 (12.1)	2310 (11.8)	962 (4.9)	13996 (71.2)	
Saw a Mental Health Professional in the last 12 months	8056 (21.0)	3019 (37.5)	5037 (62.5)	<0.0001	1669 (20.7)	1350 (16.8)	429 (5.3)	4608 (57.2)	<0.0001

*P-values are for chi-square of independence.

† having witnessed at least one of the following events: an airplane hitting the WTC, people falling or jumping from the WTC, buildings collapsing, people running away from the dust cloud or smoke and other people being injured or killed

‡ reporting at least one of the following injuries sustained on 9/11: burns, cuts/abrasions/puncture wounds, sprain/strain, fractured or dislocated bones and head injury)

§ displaced from home for at least 24 hours between 9/11/01 and 9/18/01

Table 5.3. PTSD at Wave Two and Drinking (Odds Ratios and 95% Confidence Intervals)*, Models 1 to 10								
	Model 1	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**
PTSD at Wave Two								
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes-Non-Problem Drinking	0.55 (0.52-0.60)	0.72 (0.67-0.77)	0.70 (0.65-0.76)	0.71 (0.66-0.76)	0.73 (0.68-0.78)	0.72 (0.67-0.78)	0.71 (0.66-0.77)	0.70 (0.65-0.76)
Yes-Problem Drinking	1.05 (0.98-1.13)	1.19 (1.10-1.28)	1.10 (1.01-1.19)	1.15 (1.06-1.25)	1.20 (1.11-1.30)	1.17 (1.08-1.27)	1.11 (1.03-1.21)	1.08 (1.00-1.17)

*Model 1: unadjusted; Model 4: adjusted for: age, gender, race/ethnicity, income, marital status, education, depression, smoking and mode of enrollment; Model 5: additionally adjusted for peri-disaster experiences; Model 6: adjusted for income, marital status, education, depression, smoking, mode of enrollment and social support; Model 7: adjusted for income, marital status, education, depression, smoking, mode of enrollment and mental health care utilization; Model 8: adjusted for income, marital status, education, depression, smoking, mode of enrollment, social support and mental health care utilization; Model 9: adjusted for income, marital status, education, depression, smoking, mode of enrollment, peri-disaster experiences and mental health care utilization; and Model 10: adjusted for income, marital status, education, depression, smoking, mode of enrollment, peri-disaster experiences, social support and mental health care utilization

Table 5.4. PTSD at Wave Two and Drinking (Odds Ratios and 95% Confidence Intervals)* by Peri- and Post Disaster Experiences

	Social Support	
	Low	**High**
PTSD at Wave Two		
No	1.00	1.00
Yes-Non-Problem Drinking	0.67 (0.61-0.74)	0.77 (0.68-0.87)
Yes-Problem Drinking	1.00 (0.90-1.11)	1.25 (1.09-1.43)
	Mental Health Care Utilization (Seen a mental health provider)	
	No	**Yes**
PTSD at Wave Two		
No	1.00	1.00
Yes-Non-Problem Drinking	0.77 (0.69-0.84)	0.65 (0.57-0.75)
Yes-Problem Drinking	1.25 (1.13-1.38)	0.89 (0.77-1.03)

*adjusted for age, gender, race/ethnicity, income, marital status, education, depression, smoking and mode of enrollment. In addition, the estimates for social support are adjusted for experience group and mental health care utilization; and the ones for mental health care utilization are adjusted for experience group and social support.

Chapter 6

Conclusions and Recommendations

This chapter summarizes the findings and conclusions of this study. It then describes the main strengths and limitations of the research. Finally, it highlights possible directions for future research and the implications of the findings for health policy and practice.

Summary of Findings and Conclusions

This dissertation makes contributions to the literature on the effects of a disaster, specifically the events of 9/11, on post-disaster problem drinking and on the relationship between PTSD and problem drinking. This study found that there is a significant association between PTSD and problem drinking after controlling for selected sociodemographic characteristics. However, this association is only marginally significant after additionally adjusting for selected sociodemographic characteristics and peri-and post-disaster experiences. This suggests that peri- and post-disaster experiences may be stronger predictors of problem drinking in general, independent of PTSD, and points to an important area for further examination in this population. Our findings also showed that the odds of problem drinking was significantly greater among those with late-onset PTSD compared to those with no PTSD even after controlling for peri-and post-disaster experiences. This suggests that risk factors associated with the delayed development of PTSD may also be associated with problem drinking and underscores a second area for future research.

Because of the large and diverse population of enrollees in the Registry, we were able to examine the heterogeneity of the association between PTSD and problem drinking across selected sociodemographic characteristics and peri-and post-disaster experiences. As such, we have concluded that the association between PTSD and problem drinking

does in fact vary by age, gender, race/ethnicity, level of social support and mental health care utilization after controlling for selected covariates. We found a significant positive association between PTSD and problem drinking among those aged 30 to 64 years old, men, women, blacks, Hispanics/Latinos, Asians, enrollees categorized as multiracial/other, enrollees with high social support and enrollees who had not seen a mental health provider. We found a significant negative association between PTSD and non-problem drinking among 18-64 year olds, men and women, whites, and Hispanics. PTSD and non-problem drinking were negatively associated regardless of mental health care utilization or social support. Thus, our findings suggest that groups that may be overlooked for problem drinking, such as Asians, Blacks, 45 to 64 year olds and those with high social support, are in fact the most likely to problem drink when they have PTSD.

Our findings along with previous studies[1-5, 9, 14-24] demonstrate that survivors of complex disasters are at increased risk for the development of acute and chronic mental health problems, like PTSD and problem drinking. Despite the fact that the events of 9/11 were unique, other complex emergencies that expose large numbers of people to a variety of traumatic events are not. As such, it is crucial that public health practitioners, particularly those working in disaster planning and mental health include screening for increases in alcohol use and problem drinking as part of post-disaster psychological evaluations.

Strengths and Limitations

This study has several strengths, among them its large sample size; the range of data on sociodemographic characteristics and the diversity of the study population. This is the first study on PTSD and alcohol use in such a large sample of individuals directly exposed to a disaster or act of terrorism. Previous studies on post-9/11 alcohol use have been limited to broad based samples of NYC[1-4] or NJ residents[5], of which those that experienced 9/11 firsthand were the minority. The World Trade Center Health Registry (Registry) is the largest post-disaster registry in the US and contains extensive data on individual characteristics of enrollees affected by the events of 9/11 as well as numerous peri- and post-disaster experiences. Furthermore, the sample comprises a wide and diverse group of persons directly exposed to the 9/11 disaster, including a wider range of racial/ethnic groups than previous studies, which were limited primarily to English and Spanish speakers.[1-4] Asians, in particular Cantonese and Mandarin speakers, are included in this study, but have been left out of several previous studies[1-4], despite the fact that they represent a large proportion of those directly affected by the 9/11 disaster, given its proximity to the area of Manhattan with a high number of Chinese-ancestry residents. Furthermore, because the Registry represents only a portion of those directly affected by 9/11, we know that the Registry findings are significant for a wider segment of the population.

In addition, disasters, both man-made and natural, often provide researchers with a natural experiment, in which exposure to the traumatic event is not confounded by personality traits, pre-existing conditions or familial history.[5] The 9/11 disaster was an event which exposed people to trauma regardless of an individuals' prior history of

trauma or alcohol use. Therefore, the effects of different levels of exposure or proximity to the event and their subsequent effects on mental health as well as substance use was considered.[5]

Finally, although the events of 9/11 were unique, some of its essential characteristics – high initial mortality, wide population exposure, prolonged exposure to the aftermath of recovery and repair, and extensive media coverage – characterize other human and natural disasters that affect dense urban populations. Thus, some of the findings reported here may be relevant to a better understanding of the mental health consequences of other disasters.

Despite its numerous strengths, this study has several limitations. Among the limitations of the study are its cross-sectional nature, the fact that most data were self-reported and the limited information on alcohol use. However, the main limitation pertains to the assessment of alcohol use. Alcohol use was not assessed at Wave 1, nor were enrollees asked about their lifetime histories of drinking. As a result, this study cannot establish the directionality of the relationship between PTSD and alcohol use. However, given the diversity of the population groups enrolled in the Registry, this study can contribute to the literature by identifying groups with a higher likelihood of problem drinking after the development of PTSD.

The Registry collected Wave 1 data two to three years after the disaster and Wave 2 data five to six years after the event, relying on self-reported exposure and health information**.** As a result, some enrollees may have under-reported their exposures or made errors in their histories because they had forgotten details over time. Other

enrollees that were still physically ill or suffering from PTSD may have been more likely to over-report their exposures. This may have resulted in a bias towards the null.

Most Registry enrollees were self-identified, that is, they responded to the Registry's general outreach campaign rather than having been recruited from lists of potentially affected individuals provided by government agencies or area employers. Although individuals gained neither monetary nor legal benefit by enrolling in the Registry, it is assumed that individuals experiencing a greater number of symptoms were more likely to enroll than those that remained symptom free. This may have resulted in a bias away from the null. Individuals may have under-reported their alcohol use in order to provide a socially desirable response or because they were unable to accurately estimate their own alcohol use. This may have resulted in differential misclassification as individuals that were problem drinkers may be misclassified as non-problem drinkers or non-drinkers. This may have biased the results towards the null and provided an underestimate of the burden of problem drinking in this population. Response bias may also have affected individuals' responses to the mental health questions and in that case could have biased the results towards or away from the null. It is unlikely that the under-reporting of alcohol use and the over-reporting of PTSD symptoms changed the results presented here, as the two effects would cancel each other out, ultimately resulting in an underestimation of the association between PTSD and alcohol use.

Another limitation of this study pertains to differences between those included in the study and those excluded. The first group excluded from this study was those who did not respond to the Wave 2 survey (non-respondents). According to published findings from the Wave 2 survey, those who did respond (respondents) were more likely to be

self-identified, English speaking, male, aged 45 to 64, non-Hispanic whites, of higher income and former smokers.[9] Therefore, these factors were considered and adjusted for in the analysis. Respondents had a significantly lower prevalence of PTSD symptoms at Wave 1 than non-repsondents.[9] Enrollees with more PTSD symptoms may have been less likely to respond to Wave 2 due to avoidance symptoms. Subsequently, this may lead to an underestimation of the association between PTSD and problem drinking.

Also excluded from the study were enrollees who did not complete questions on the exposure or outcome of interest. It is possible that those not completing the PCL-17 may have been more likely to have PTSD symptoms, and therefore, their exclusion could lead to an underestimation of the association. Individuals not completing the alcohol questions may have been more likely to be problem drinkers, which would also bias our results towards the null.

Finally, enrollees missing any other covariate were excluded from the study. Because those excluded differed significantly (P-value <0.0001; see Appendix B) from the included group a sensitivity analysis was performed. This was done by estimating the crude odds ratio for the association between PTSD and drinking for data on those included and excluded groups combined and comparing it to the crude odds ratio for the included group. The two ratios did not differ significantly (OR: 1.03; 95% CI: 0.97-1.10 and OR: 1.05; 95% CI: 0.98-1.13 respectively). Therefore, we conclude that these exclusions will not impact the validity of our findings.

Public Policy and Practice Implications

The increased odds of post-disaster problem drinking found in this study, particularly among those with PTSD, indicates the need for screening for both PTSD and problem drinking in communities affected by complex disasters and emergencies. Both Hurricane Katrina and the British Petroleum oil spill in the Gulf of Mexico highlighted the impact of disasters on the mental health and drinking patterns of those affected. This reinforces that the effects seen after 9/11 were not unique and highlights the importance of including mental health issues in emergency planning.

It is important that individuals at-risk for problem drinking be screened using an appropriate screening tool. It is currently recommended in the Registry's clinical guidelines for physicians treating individuals exposed to 9/11 to screen for alcohol use with the CAGE questionnaire.[10] The CAGE is so-named as a mnemonic device to remember the four questions, "Have you ever: 1) felt the need **cut** down your drinking; 2) been **annoyed** by criticism of our drinking; 3) had **guilty** feelings about drinking 4) and taken a morning **eye-opener?"**[11] While the CAGE is a useful tool to screen for alcohol use disorders (alcoholism, alcohol abuse or dependence), it does not detect heavy drinking and cannot distinguish between active and past problem drinking.[11, 12] These drinking patterns may increase an individual's risk for alcohol-related physical and mental health problems or alcohol use disorders and are important to detect at an early stage. The Alcohol Use Disorders Identification Test (AUDIT) is a ten question screening tool that assesses alcohol consumption and is used to detect both current heavy drinking as well as alcohol use disorders.[12] The AUDIT-C is an abbreviated three question version of the AUDIT and is particularly useful in identifying heavy drinkers that might benefit

from brief interventions.[12] When time permits, individuals scoring above a specific cut-off may be asked the remaining seven AUDIT questions in order to screen for abuse or dependence. Therefore it is our recommendation that the AUDIT be the alcohol screening tool recommended in emergency planning. As such, because those in emergency planning look to the Registry's guidelines as a template for future policy decisions, it is our suggestion that the Registry recommends the use of the AUDIT-C and the full AUDIT instead of the CAGE as an alcohol screening tool in its next version.

In addition, the prevalence and duration of post-disaster mental health sequalae like PTSD and problem drinking demonstrate the need for a health work force that is prepared to address these needs both immediately and in the long-term. It is imperative to create a pre-disaster training plan that will equip first responders, Medical Reserve Corps members, Community Emergency Response Teams, staff members of hospitals and community health centers, school counselors and others that may be an early point of contact for disaster exposed individuals with the skills necessary to provide psychological first aid, which includes an alcohol use assessment. In the Psychological First Aid: Field Operations Guide from the National Center for PTSD, first responders and others involved in post-disaster relief efforts are advised to gather information about prior history of and current alcohol use.[13] These guidelines are useful. However, because mental health, substance and alcohol use are sensitive topics, it is crucial that those who perform alcohol screenings receive adequate training to discuss these issues. It is our recommendation that state and local government agencies require trainings on psychological first aid for health personnel that may be involved in post-disaster relief efforts.

After the events of 9/11, we saw the importance of immediate post-disaster counseling provided by programs like the American Red Cross and Project Liberty, a New York State and federally-supported mental health program. However, these programs were not meant to be long-term. Our findings showed a high prevalence of late-onset PTSD among enrollees, accompanied by an increased likelihood of problem drinking after adjusting for sociodemographic characteristics and peri-and post-disaster experiences. This demonstrates that a significant portion of directly affected individuals are still at-risk for negative mental health outcomes several years after a disaster. As such, the Registry is currently conducting outreach to enrollees who reported PTSD symptoms in an effort to connect them to services.

Unfortunately, one of the main sources of low-cost mental health care for 9/11 victims is now ending due to a lack of funding. This will put a strain on the remaining free services. Therefore, we urge policy makers to continue funding for 9/11 programs by passing legislation that allows these programs to expand and continue offering services, including mental health services.

Future Research Directions

As described previously, the association between PTSD and problem drinking was only marginally significant after adjustment for both peri- and post-disaster experiences. These findings suggest that problem drinking in this population may be driven more by post-disaster experiences rather than PTSD in this population. Therefore, future studies among enrollees need to probe more deeply and examine the association between these factors

and problem drinking, particularly among enrollees with late-onset PTSD, low social support or currently receiving mental health care.

The Registry is presently designing its third survey, which is expected to be launched in early 2011. The results of the Wave 3 survey will allow for a longitudinal examination of problem drinking as well as PTSD. The Wave 3 results can be used to examine changes in drinking pattern between Waves 2 and 3 among enrollees with and without PTSD to determine if there is a difference between waves. It is our recommendation that the Registry include a question from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) on Wave 3. The question, "Did you EVER drink alcohol to improve or make yourself feel better when you were having some of these reactions to a stressful event?" If this question is placed after the PTSD questionnaire, it will allow us to begin to understand the motivation behind enrollees' alcohol use, that is are enrollees intentionally self-medicating with alcohol to ameliorate their PTSD symptoms. For an even greater understanding of alcohol use among enrollees, the Registry may also wish to consider an in-depth study among a smaller group of enrollees which focuses on the use of alcohol and other substances.

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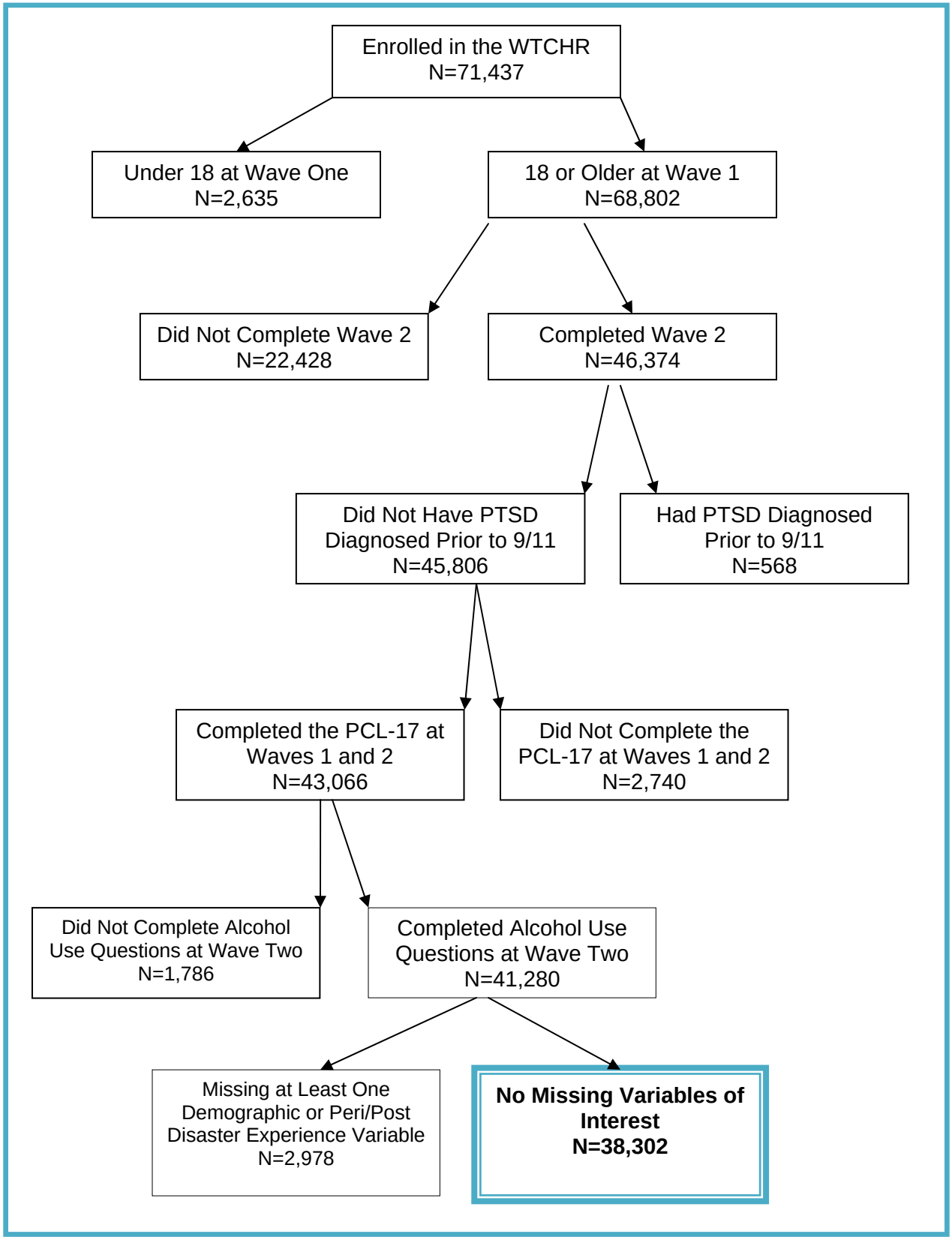
Appendices

Appendix A
Study Eligibility Diagram



Appendix B
Included Enrollees Compared to Excluded Enrollees on Exposure, Outcome and Covariates of Interest

	Included	Excluded	P-value*
Demographic Characteristics	%	%	
Age at Wave Two (years)			
18-29	5.8	5.9	<0.001
30-44	37.9	25.1	
45-64	50.4	55.1	
65+	5.9	13.9	
Gender			
Male	62.4	54.7	<0.001
Female	37.6	45.4	
Race/Ethnicity			
Non-Hispanic White	72.7	54.2	<0.001
Non-Hispanic Black	9.0	15.6	
Hispanic or Latino	10.7	14.3	
Asian	4.7	9.8	
Multiracial/Other	2.8	6.0	
Marital Status			
Married/Living with Partner	69.6	61.3	<0.001
Divorced/Separated/Widowed	13.4	20.6	
Never married	17.0	18.1	
Education			
College/Post Graduate	55.2	40.5	<0.001
Some College	24.7	25.0	
HS Graduate/GED	17.5	23.0	
Less than HS	2.5	11.4	
2002 Household Income			
$\geq$ 100,000	29.1	17.0	<0.001
75,000-99,999	18.7	13.1	
$50,000-74,999	19.9	18.2	
$25,000-49,999	16.8	22.3	
Missing	8.9	14.6	
$\leq$ $24,999	6.7	14.8	
Tobacco Use At Wave Two			
Yes	13.4	14.4	0.0167
No	86.6	85.6	
Ever Diagnosed with Depression			
Yes	22.8	29.4	<0.001
No	77.2	70.6	
PTSD at Wave 2			
Yes	18.6	24.5	<0.001
No	81.36	75.5	

	Included	Excluded	P-value
PTSD Group			
Chronic (W1+, W2+)	9.2	13.1	<0.001
Late Onset	9.5	10.9	
Resolved	4.4	6.8	
No PTSD	76.9	69.2	
Enrollment			
List-Identified	25.2	31.2	<0.001
Self-Identified	74.8	68.8	
Wave Two Survey Mode			
Mail (Paper)	43.8	57.4	
Phone	9.1	26.2	
Web	47.1	16.4	
Alcohol Use			
Problem	29.3	23.3	<0.001
Non-Problem	48.6	42.9	
No Alcohol Use	22.1	33.7	
Peri-Disaster Experiences			
Caught in the Dust Cloud on 9/11	51.8	52.8	0.1168
Witnessed Tragedy on 9/11[a]	52.5	53.4	0.1080
Afraid of Injury or Death on 9/11	54.4	55.4	0.1340
Sustained an Injury on 9/11[b]	13.1	14.3	0.0057
Bereavement as a result of 9/11	58.2	54.3	<0.001
Displaced from Home [c]	10.9	10.8	0.7543
Worked in Rescue/Recovery	47.2	42.6	<0.001
9/11-Related Job Loss or Unemployment	7.6	11.1	<0.001
Total Number of Peri-Disaster Experiences			
0	1.7	2.7	<0.001
1 to 2	40.0	38.8	
3 to 4	42.1	40.7	
5 to 6	15.6	17.1	
7 to 8	0.7	0.8	
Post-Disaster Experiences			
Social Support			
High	48.7	42.7	<0.001
Low	51.3	57.4	
Saw a Mental Health Professional in the last 12 months	21.0	23.6	<0.001

*P-values for Chi-square of Independence.

Appendix C
Alcohol Use at Wave Two Variables for enrollees with alcohol use information at Wave 2
Please note: derived variables are listed across the top and should be read downwards to see which survey questions they correspond to.

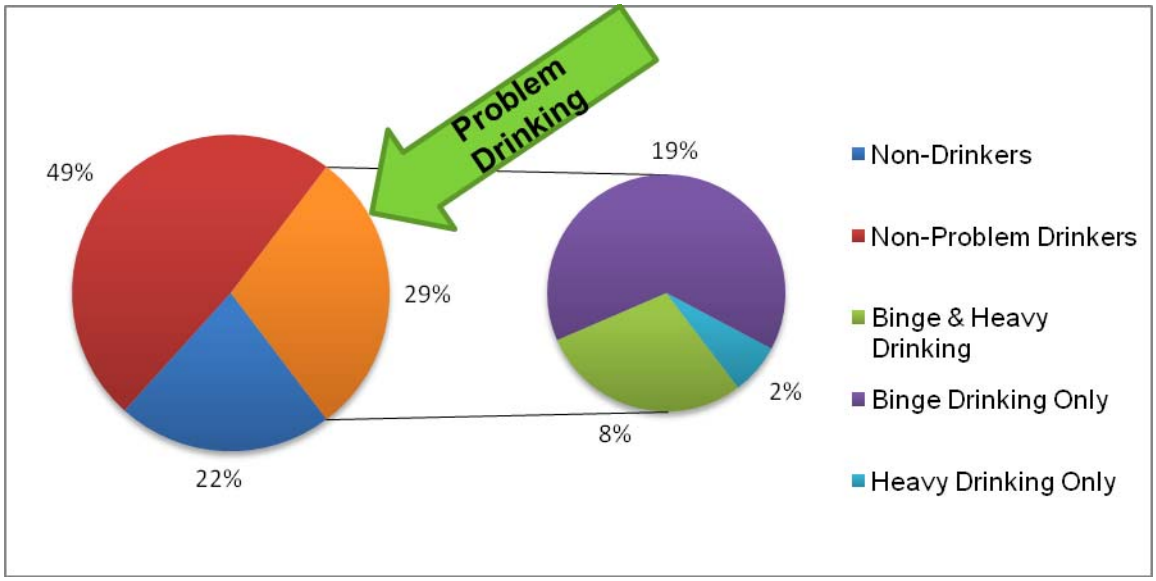
	No Drinking in the Last 30 Days	Non-Problem Drinking in the Last 30 Days		Problem Drinking in the Last 30 Days			
				Heavy Drinking		Binge Drinking	
		Males	Females	Males	Females	Males	Females
Number of Drinking Days = "During the last 30 days, how many days per week or per month, did you have at least one drink of any alcoholic beverage?" *	0, and	≥1, and	≥1, and	1, and	1, and	1, and	1, and
Drinks per Day = "On the days when you drank, about how many drinks did you drink on average?" [in the last 30 days] *	0, and					≥5, or	≥4, or
Average Daily Consumption= (# of drinking days * average # of drinks per drinking day) / 30	0, and	≤2, and	≤1, and	>2	>1		
Episodes of Binge Drinking = "Considering all types of alcoholic beverages, how many times during the last 30 days did you have 5 or more drinks on one occasion?"*	0	0	0			≥1	≥1

*Wave 2 Survey Question

Appendix D: Trajectory of probable PTSD for enrollees with information at Waves 1 and 2

	Probable PTSD at Wave 1	Probable PTSD at Wave 2
Chronic	Yes	Yes
Late Onset	No	Yes
Resolved	Yes	No
No PTSD	No	No

Appendix E: Drinking patterns among enrollees with alcohol use information at Wave 2



Appendix F

	PTSD Trajectory and Drinking (Odds Ratios and 95% Confidence Intervals)*					
	Model 1		Model 4		Model 10	
	Non-Problem Drinking	Problem Drinking	Non-Problem Drinking	Problem Drinking	Non-Problem Drinking	Problem Drinking
PTSD Trajectory						
Chronic	0.46 (0.42-0.50	0.86 (0.79-0.94)	0.68 (0.62-0.75)	1.17 (1.05-1.30)	0.66 (0.60-0.73)	1.03 (0.93-1.15)
Late-Onset	0.65 (0.59-0.71)	1.24 (1.14-1.36)	0.74 (0.68-0.82)	1.21 (1.10-1.34)	0.73 (0.66-0.80)	1.12 (1.01-1.24)
Resolved	0.71 (0.63-0.80)	0.73 (0.64-0.84)	0.95 (0.84-1.07)	1.03 (0.89-1.19)	0.92 (0.81-1.05)	0.96 (0.83-1.11)
No PTSD	1.00	1.00	1.00	1.00	1.00	1.00

*Model 1: unadjusted; Model 4: adjusted for: age, gender, race/ethnicity, income, marital status, education, depression, smoking and mode of enrollment; Model 10: additionally adjusted for peri- and post-disaster experiences

Appendix G

	PTSD At Wave Two and Drinking (Odds Ratios and 95% Confidence Intervals)*					
	Model 1		Model 4		Model 10	
	Non-Problem Drinking OR (95% CI)	Problem Drinking OR (95% CI)	Non-Problem Drinking OR (95% CI)	Problem Drinking OR (95% CI)	Non-Problem Drinking OR (95% CI)	Problem Drinking OR (95% CI)
PTSD at Wave Two						
Yes	0.55 (0.52-0.59)	1.05 (0.98-1.13)	0.72 (0.67-0.77)	1.19 (1.10-1.28)	0.70 (0.65-0.76)	1.08 (1.00-1.17)
No	1.00	1.00	1.00	1.00	1.00	1.00
Demographic Characteristics						
Age at Wave Two (years)						
18-29	2.12 (1.81-2.48)	11.31 (9.33-13.72)	2.35 (1.98-2.78)	12.73 (10.38-15.63)	2.35 (1.98-2.78)	12.47 (10.16-15.32)
30-44	1.67 (1.51-1.85)	6.14 (5.29-7.12)	1.44 (1.30-1.60)	4.87 (4.17-5.68)	1.42 (1.28-1.59)	4.59 (3.93-5.36)
45-64	1.42 (1.29-1.56)	3.30 (2.85-3.82)	1.23 (1.11-1.36)	2.50 (2.14-2.91)	1.22 (1.10-1.35)	2.39 (2.05-2.78)
65+	1.00	1.00	1.00	1.00	1.00	1.00
Gender						
Male	1.23 (1.16-1.29)	2.15 (2.02-2.28)	1.14 (1.07-1.21)	2.10 (1.96-2.24)	1.13 (1.07-1.20)	2.06 (1.92-2.20)
Female	1.00	1.00	1.00	1.00	1.00	1.00
Race/Ethnicity						
Non-Hispanic White	1.38 (1.18-1.60)	1.56 (1.32-1.85)	1.20 (1.02-1.40)	1.40 (1.17-1.67)	1.20 (1.03-1.40)	1.41 (1.18-1.68)
Non-Hispanic Black	0.82 (0.69-0.96)	0.53 (0.44-0.64)	0.94 (0.80-1.12)	0.68 (0.56-0.83)	0.93 (0.78-1.10)	0.66 (0.54-0.81)
Hispanic or Latino	0.85 (0.72-1.00)	0.96 (0.80-1.16)	1.04 (0.88-1.23)	1.04 (0.86-1.26)	1.02 (0.86-1.21)	1.00 (0.82-1.22)
Asian	0.70 (0.58-0.84)	0.47 (0.38-0.58)	0.62 (0.52-0.75)	0.41 (0.33-0.51)	0.61 (0.50-0.73)	0.40 (0.32-0.50)
Multiracial/Other	1.00	1.00	1.00	1.00	1.00	1.00
Marital Status						
Married/Living with Partner	1.01 (0.94-1.08)	0.84 (0.78-0.91)	0.85 (0.79-0.92)	0.72 (0.66-0.78)	0.85 (0.79-0.92)	0.72 (0.66-0.78)
Divorced/Separated/Widowed	0.71 (0.65-0.78)	0.57 (0.52-0.64)	0.92 (0.83-1.01)	0.91 (0.81-1.02)	0.92 (0.83-1.01)	0.91 (0.81-1.02)
Never married	1.00	1.00	1.00	1.00	1.00	1.00
Education						
College/Post Graduate	3.82 (3.28-4.45)	2.57 (2.18-3.02)	2.16 (1.84-2.54)	1.61 (1.34-1.93)	2.19 (1.87-2.58)	1.64 (1.36-1.97)
Some College	2.35 (2.01-2.75)	2.10 (1.78-2.49)	1.50 (1.28-1.77)	1.33 (1.10-1.60)	1.51 (1.28-1.78)	1.32 (1.10-1.59)
HS Graduate/GED	1.70 (1.45-1.99)	1.61 (1.36-1.91)	1.18 (1.00-1.40)	1.10 (0.91-1.33)	1.18 (1.00-1.39)	1.08 (0.90-1.31)
Less than HS	1.00	1.00	1.00	1.00	1.00	1.00

	Non-Problem Drinking	Problem Drinking	Non-Problem Drinking	Problem Drinking	Non-Problem Drinking	Problem Drinking
2002 Household Income						
≥ 100,000	3.65 (3.28-4.07)	2.85 (2.54-3.19)	2.71 (2.40-3.06)	2.81 (2.45-3.21)	2.68 (2.38-3.03)	2.75 (2.41-3.15)
75,000-99,999	2.31 (2.07-2.58)	1.94 (1.73-2.19)	1.90 (1.68-2.15)	1.88 (1.64-2.15)	1.89 (1.67-2.13)	1.85 (1.62-2.12)
$50,000-74,999	1.90 (1.70-2.11)	1.51 (1.34-1.69)	1.63 (1.45-1.83)	1.51 (1.32-1.72)	1.62 (1.45-1.82)	1.50 (1.32-1.71)
$25,000-49,999	1.25 (1.12-1.39)	0.94 (0.84-1.06)	1.17 (1.04-1.31)	1.02 (0.89-1.16)	1.16 (1.04-1.30)	1.02 (0.90-1.16)
Missing	2.44 (2.15-2.76)	1.22 (1.06-1.41)	2.00 (1.75-2.28)	1.35 (1.16-1.58)	1.98 (1.73-2.26)	1.34 (1.15-1.56)
≤ $24,999	1.00	1.00	1.00	1.00	1.00	1.00
Tobacco Use At Wave Two						
Yes	0.84 (0.77-0.91)	1.96 (1.81-2.13)	1.06 (0.97-1.15)	2.11 (1.94-2.31)	1.04 (0.95-1.13)	2.04 (1.87-2.23)
No	1.00	1.00	1.00	1.00	1.00	1.00
Ever Diagnosed with Depression						
Yes	0.69 (0.65-0.73)	0.94 (0.88-1.00)	0.81 (0.76-0.87)	0.97 (0.90-1.04)	0.86 (0.80-0.93)	1.01 (0.93-1.09)
No	1.00	1.00	1.00	1.00	1.00	1.00
Mode of Enrollment						
Self	1.23 (1.16-1.30)	1.35 (1.27-1.44)	1.20 (1.13-1.28)	1.26 (1.18-1.35)	1.18 (1.11-1.25)	1.19 (1.11-1.28)
List	1.00	1.00	1.00	1.00	1.00	1.00
Total Number of Peri-Disaster Experiences						
1 to 2	1.08 (0.90-1.30)	1.63 (1.29-2.07)	-	-	0.97 (0.79-1.18)	1.17 (0.91-1.51)
3 to 4	1.20 (1.00-1.45)	2.23 (1.76-2.82)	-	-	1.09 (0.89-1.32)	1.52 (1.18-1.96)
5 to 6	1.06 (0.88-1.29)	2.64 (2.07-3.36)	-	-	1.06 (0.87-1.31)	1.68 (1.29-2.18)
7 to 8	0.80 (0.55-1.16)	2.45 (1.65-3.63)	-	-	1.01 (0.69-1.49)	1.57 (1.03-2.38)
0	1.00	1.00	-	-	1.00	1.00
Post-Disaster Experiences						
Social Support						
Low	0.96 (0.91-1.01)	1.30 (1.23-1.38)	-	-	1.10 (1.04-1.16)	1.25 (1.18-1.33)
High	1.00	1.00	-	-	1.00	1.00
Seen a Mental Health Professional in the last 12 months						
No	1.27 (1.20-1.36)	1.04 (0.98-1.11)	-	-	1.17 (1.08-1.26)	1.15 (1.06-1.25)
Yes	1.00	1.00	-	-	1.00	1.00

*Model 1: unadjusted; Model 4: adjusted for: age, gender, race/ethnicity, income, marital status, education, depression, smoking and mode of enrollment; Model 10: additionally adjusted for peri- and post-disaster experiences

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