

Post-traumatic stress symptoms in the general population after a disaster: implications for public health

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Introduction

Post-traumatic stress after disasters and after September 11, 2001

Major disasters are associated with increased rates of psychological distress and morbidity among survivors (Norris *et al.*, 2002a, b; Galea *et al.*, 2005). The vast majority of post-disaster research has focused on the groups that are typically considered to be most affected by disasters and a substantial literature has documented the burden of psychopathology faced by survivors of disasters (North *et al.*, 1999; Salcioglu *et al.*, 2003) persons who are involved in the post-disaster recovery efforts (North *et al.*, 2002), and family and friends of persons who are killed or seriously injured in disasters (Stoppelbein & Greening, 2000). Post-traumatic stress disorder (PTSD) is the most commonly studied, and likely the most prevalent mental health problem in these groups after disasters (Green & Lindy, 1994; Galea *et al.*, 2005), although other mental health problems including depression (Kuo *et al.*, 2003), generalized anxiety disorder (Smith *et al.*, 1990), and non-specific psychological stress (Carr *et al.*, 1997) have been studied.

In the aftermath of the September 11 attacks there was every reason to believe that the impact of the attacks among the survivors of the attacks would be comparable to that among survivors of other major disasters. For example, in the aftermath of the bombing of the Murrah Federal Building in Oklahoma City, North and colleagues reported that 34.3% of adult survivors of the bombing who were either in the building at the time of the bombing or in close proximity had symptoms consistent with a diagnosis of PTSD in the first 6 months after the bombing (North *et al.*, 1999). Official estimates of the number of persons who were survivors of the September 11 attacks vary. A report commissioned by the New York City (NYC) Mayor's Office and conducted by a private consulting company estimated that there were 9–12,000 family members of the deceased, up to 3000 persons injured by the attacks and 12,000 residents of the immediate area around the World Trade

Center (WTC) (south of Canal Street) (NYC Fire Department, 2002). Although this was a larger number of survivors (who are traditionally both the subject of research and the focus of much of the public health attention in the aftermath of disasters) than after most other previous US disasters, this number represented a very small proportion of the total residents of the NYC metropolitan area.

A number of factors also suggested that the September 11, 2001, terrorist attacks would have substantial mental health consequences in the NYC metropolitan area that extended beyond those direct victims of the attacks. The NYC metropolitan area is the largest and the most densely populated metropolitan areas in the US (Bureau of the Census, 2000). Although estimates of population size vary, depending on the areas selected as boundaries of the metropolitan area, approximately 15 million people live in the vicinity of NYC in the tri-state area of New York State, New Jersey, and Connecticut. The attacks on the WTC were perceived as an attack on the US (Kennedy, 2001). During the day of September 11, "fog of war" rumors had many in the NYC metropolitan area afraid for their lives. Early rumors of more planes being hijacked and aimed for other NYC and national targets were rife. As round-the-clock, real-time television coverage of the attacks saturated the airwaves, millions in the area saw images of people waving for help from the towers of the WTC, and subsequently saw the towers fall. Meanwhile, countless residents of the tri-state area knew someone or were related to someone who was working in the WTC. Disrupted communications systems meant that many were uncertain about the fate of family or friends for most of the day of September 11 and, in many cases, for days after.

Therefore, in the aftermath of September 11, we developed a study to assess the potential mental health consequences of the September 11 attacks in the general population of the NYC metropolitan area (Galea *et al.*, 2002a). Underlying this work was the premise that all residents of the NYC metropolitan area were potentially exposed to the September 11 attacks, and could plausibly develop post-traumatic stress symptoms related to the attacks. There were three key research questions guiding this work. First, it was considered of paramount importance to determine the burden of post-traumatic stress in the general population a month after the September 11 attacks; this could both contribute to public mental health planning and also add new insight to the literature where there were no peer-reviewed papers documenting the early prevalence of PTSD in the general population. Second, it was considered equally important to document the course of PTSD in the general population in the months after September 11. Third, we wanted to identify specific groups that were at high risk of post-traumatic stress symptoms in the general population after the terrorist attacks and who would, as such, benefit from targeted public mental health interventions. This research group conducted a number of studies to address these questions in NYC metropolitan area. We discuss here the rationale behind the studies conducted and the study design chosen,

evidence about post-traumatic stress in the general population in the first 6 months after September 11, and the implications of this work for public health planning after major disasters in densely populated urban areas.

Study history and motivation

In the immediate aftermath of the attacks, there was a rapid mobilization of health care personnel in NYC to provide care to those injured and affected by the attacks. Mental health clinicians began assisting families of the deceased and rescue personnel who were working at the disaster site and, eventually, to residents of NYC at large. In concert with the provision of mental health services there was also clear need for assessments that could determine the scope of mental health need both among persons who were directly affected by the terrorist attacks as well as in the general population at large. In that context, The New York State Psychiatric Institute (NYSPI) began working with the Substance Abuse and Mental Health Services Administration (SAMHSA) to prepare a mental health needs assessment that could be used as part of an application for Federal Emergency Management Agency (FEMA) funding for mental health services (Herman *et al.*, 2002). In its early stages the assessment began to draw on published research. However, although previous research provided estimates of the prevalence of post-disaster mental health problems, published data had limited applicability to the NYC context. The studies that had been carried out provided estimates of the prevalence of mental health problems in the general population ranging from 2.0% to 18.3% (Hanson *et al.*, 1995; Carr *et al.*, 1997). Thus, it became clear that a primary role for public health researchers in NYC would be to characterize the mental health consequences of the attacks in NYC, both among those directly affected by the attacks, and in the NYC population at large.

The Center for Urban Epidemiologic Studies (CUES), the institution primarily responsible for the research discussed here, is a division of the New York Academy of Medicine (NYAM). CUES is a research institute comprised of epidemiologists and physicians with an interest in the health of urban populations. CUES research is funded by the Centers for Disease Control and Prevention, the National Institutes of Health (NIH), and by private foundations. CUES was explicitly founded as an unaffiliated center that could work through collaborations with other academics in NYC and throughout the country. Throughout its history CUES had worked collaboratively with a number of universities in NYC and in other parts of the country. Also, prior to September 11, the epidemiology of emergent conditions, including the epidemiology of mental health after severe trauma was one of the research interests at CUES. As such, investigators at CUES had both an *a priori* interest in the questions that were rapidly emerging in the aftermath of the attacks and were well positioned to develop a project which would require the collaboration of researchers

and practitioners at multiple institutions. Approximately a week after September 11, in consultation with the New York Department of Health and Mental Hygiene (NYDOHMH), NYSPI, and SAMSHA, CUES investigators started work on designing, and implementing, research that could estimate the prevalence of mental health problems in the general population and identify groups who were particularly at risk of psychopathology and who could benefit from acute mental health intervention.

In deciding to develop an assessment to document the mental health consequences of the September 11 attacks in the NYC population at large, CUES investigators sought to collaborate with other investigators and institutions with specific experience in post-disaster research. The National Crime Victims Research and Treatment Center (NCVC) is a division of the Department of Psychiatry and Behavioral Sciences at the Medical University of South Carolina in Charleston, South Carolina. The primary focus of NCVC investigators is to understand the impact of violence on adults, children, and their families. In more recent years, NCVC research efforts have expanded to include an examination of the mental health impact of natural disasters and urban violence. NCVC studies have been sponsored by agencies and organizations such as the NIH and the National Institute of Justice. NCVC researchers are often involved in providing consultation to other researchers and agencies interested in pursuing work related to the psychological consequences of severe trauma and disasters.

One of the major projects carried out by NCVC was the National Women's Study (NWS), a large epidemiological research project that involved the assessment of national household probability samples of adult women about a variety of topics including history of traumatic events, PTSD, and major depression (Resnick *et al.*, 1993; Kilpatrick *et al.*, 1997). These assessments happened via telephone over a 3-year period between 1989 and 1993. As part of this project, NCVC researchers had developed and validated modified diagnostic measures for PTSD and depression that were particularly relevant to the work that CUES investigators were considering in NYC. The NWS PTSD module probably represents the most widely used telephone instrument for lay-assessment of PTSD that is currently extant and as such lent itself particularly well to the planned assessment of the burden of psychopathology in the general population that was being planned by investigators at CUES.

In addition to looking for content expertise in a collaboration with NCVC, CUES investigators also sought to collaborate with an institution with expertise, and a track record in rapid implementation of population representative surveys. CUES had previously collaborated with Schulman, Ronca, & Bucuvalas Inc. (SRBI), a global research firm based in NYC, in conducting the Harlem Social Environment Study (Galea *et al.*, 2001). SRBI specializes in public policy and opinion surveys, health care, and communications and has a long track record collaborating with academic institutions. Coincidentally, SRBI also had been responsible

for implementing the NWS in collaboration with NCVC investigators making a CUES-NCVC-SRBI collaboration natural to guide the planned research. Ultimately, all three parties involved in organizing this research were committed to its rapid and rigorous execution. CUES' status as an unaffiliated small institution, relatively unencumbered by much of the bureaucracy that is often endemic in larger institutions and with a history of carrying out rapid epidemiological studies was a catalyst for moving quickly on implementing the post-September 11 research described here. NCVC and SRBI both understood the importance of implementing research rapidly and the three teams worked around the clock in the first few weeks after September 11 to implement the first phases of this research.

Choosing a research design

There were several considerations that guided the choice of research design at project inception. Principal among these was the necessity for a rapid assessment that could contribute data to the ongoing NYSPI and SAMSHA mental health needs assessment. Recognizing that the extant literature that had studied the prevalence of PTSD in the general population provided a broad range of possible estimates, and that previous studies had been conducted at least 6 months after disasters, implementing an intervention that could assess the burden of post-traumatic stress in the general population 1 month after the September 11 attacks was considered of paramount importance. Two principal study designs and three primary sampling methods were considered.

The first decision that had to be made was the specific study design to be employed. Given our interest in documenting both the baseline burden and the course of post-traumatic stress in the general population, we first sought to implement a prospective cohort study whereby participants could be recruited 1 month after the September 11 attacks and subsequently followed up over the coming years. However, there were two factors that precluded the implementation of a cohort study in this context. The first limitation was one of human subjects protection. In the aftermath of September 11, given the widespread consequences of the attacks throughout NYC, coordination of committee meetings and space for quiet discussion were difficult to come by. In consultation with the Institutional Review Board (IRB) at NYAM, it was apparent that it would not be feasible to fully review a cohort study and the necessary attendant human subjects precautions in the month after the attacks. As such, it was decided that the first wave of this research should be anonymous; that is, that no identifying data would be collected about any respondent enrolled in the study. With this decision in place, NYAM IRB provided expedited approval of the study protocols on October 2, 2001. This precluded longitudinal follow-up of respondents or collection of any potentially identifying data such as addresses (the intersection closest to respondents' residence

was instead collected as a means of determining distance from the WTC site). We then opted to implement a serial cross-sectional study design in order to permit assessment of the course of post-traumatic stress symptoms after the September 11 attacks while obtaining only anonymous data. The serial cross-sectional study implemented was designed to mimic a natural history study, whereby persons recruited in each subsequent cross-section were persons who were living in NYC on September 11, 2001, and as such persons who would have been eligible for each of the survey waves. The second factor that precluded the implementation of a cohort study was financial. Although, as described below, funding was eventually obtained to permit the implementation of three cross-sectional surveys, at the time these studies were being designed there was no assurance of funding availability nor that funds would become available in time to implement what was recognized to be a time sensitive project. As such, a serial cross-sectional design that could add survey waves as funding became available was considered optimal and was the eventual study design implemented.

With respect to sampling method to implement in this study design, the investigators first considered the possibility of carrying out in-person interviews. However, in the first weeks after the disaster, security measures throughout NYC prevented movement south of 14th Street (the area closest to the WTC) making door-to-door contact with an important portion of NYC residents difficult. In addition, experience at SRBI suggests that door-to-door interviews in NYC is particularly difficult given the high prevalence of high rises with doormen preventing access to a random sampling of households. Second, was the possibility of carrying out a phone survey with a complex, stratified, phone sampling technique that would selectively over-sample persons who were directly affected by the event (e.g., families of victims, persons who were in the WTC during the attacks) for comparison with the general population. This option was considered not feasible due to the cost that would be associated with screening for these subgroups specifically. Although the September 11 attacks affected a large number of persons, screening for those directly affected in NYC at large would require an estimated 50 screening interviews for every target person interviewed making the cost associated with such a project prohibitive. The third option and the option eventually chosen by the research group, was a simple area probability random digit dial (RDD) survey of residents of NYC. This option was considered feasible, and would provide the research team with estimates of mental health problems in the general NYC population that could guide the ongoing needs assessment.

There were a number of reasons why it was considered optimal to carry out RDD telephone survey sampling in this context. First, telephone survey methods have been shown to be an efficient method for collecting information from large representative samples of respondents at a relatively low cost with non-significant response bias or

detection of critical variables of interest as compared to in-person interview approaches (Weeks *et al.*, 1983; Simon *et al.*, 1993). In addition, studies suggest that telephone assessments of psychiatric conditions produce results that are comparable to those obtained through in-person assessments. For example, one study compared telephone and in-person assessment of *Diagnostic and Statistical Manual for Mental Disorders, Third Edition* (DSM-III) Axis I disorders, including anxiety disorders, affective disorders, alcoholism, and no mental disorder using a structured diagnostic interview. Kappas ranging from 0.69 to 0.84 were obtained, even with a delay between in-person and telephone methods of 12–19 months (Paulsen *et al.*, 1988). RDD telephone survey method has been gaining in importance in public health research and surveillance in the past decade and is currently used routinely in important national projects such as the Centers for Disease Control Behavioral Risk Factor Surveillance System (BRFSS) which assesses risk behaviors within the adult population.

In addition to these decisions about study design and sampling methodology, other decisions had to be made about sampling area, languages to use in the surveying, and several other design details that would ultimately have bearing on the final results documented. Although there was a strong interest in carrying out the initial assessment of all of NYC and in a variety of languages, uncertainty about funding that would be available for this project suggested that a more limited sampling frame would have to be selected at least for the first stages of the project. After some discussion it was decided that the first survey wave would sample residents of Manhattan living south of 110th Street for three primary reasons. First, this was the area of Manhattan closest to the WTC site of the September 11 attacks. Second, given finite resources, a broader geographic focus would have diluted the representation of those directly affected. Third, a substantial proportion of residents of Manhattan's Upper West and Upper East sides worked in southern Manhattan and were thus more likely to witness the attacks or to be affected directly (through loss of relatives or colleagues) or indirectly (through loss of employment) by the attacks. Time considerations limited this first assessment to English and Spanish. The survey was translated and back translated into Spanish and surveying was carried out in English and Spanish using bilingual interviewers. Funding for both the first assessment and for subsequent surveying became available about a week before the first assessment started. As such, subsequent surveys were conducted in all of NYC and in the NYC metropolitan and included other languages in the assessments.

Funding

One of the primary difficulties faced by the research group in carrying out this work was obtaining funding, or assurance of funding, to carry out this research. Although early on all the investigators were donating their time to the project in-kind, financial resources were needed to fund the data collection. It was clear early on

that if the assessment was to be implemented early after September 11, preparations for the research would have to be made in the absence of assurances of funding. In the early weeks after the September 11 attacks, several NYC foundations were formed with the explicit intent of funding post-September 11 relief efforts. However, the vast majority of these resources were earmarked for clinical relief services. In the weeks after September 11, the investigative team approached private foundations and federal funding agencies for resources to carry out the assessment. Although the majority of the requests were unsuccessful, assurances of funding eventually were obtained from the National Institute on Drug Abuse (in the form of an administrative supplement to an ongoing research project) and from The New York Community Trust/United Way Consortium that had been formed to administer donations received for post-September 11 work. Assurances of funding were received about a week before the start of data collection. Eventually funding was also obtained from the National Institute on Mental Health that permitted the subsequent survey waves.

Methods

Sample

Overall, three serial cross-sectional RDD household surveys were conducted. The first survey ($n = 988$) was conducted between October 16 and November 15, 2001, the second survey ($n = 2001$) was between January 15 and February 21, 2002, and the third survey ($n = 2752$) was between March 25 and June 25, 2002. The sampling frame for survey 1 included adult residents (18 years of age or older) of Manhattan living south of 110th Street. The sampling frame for survey 2 included all adults in NYC with an over-sampling of residents of Manhattan living south of 110th Street to permit comparison between surveys. The sampling frame for survey three included all adults in the NYC metropolitan area with over-sampling of residents of Manhattan south of 110th Street and of NYC to permit comparison among surveys. Further detail about these surveys is available in other work published by the authors (Galea *et al.*, 2002a, b, c; Galea *et al.*, 2003; Vlahov *et al.*, 2002; Vlahov *et al.*, 2004). Here, we present results from survey 3. The sampling frame for this survey included all adults in the following contiguous geographic areas: NYC and Nassau, Westchester, Suffolk, and Rockland counties in New York State, Hudson, Essex, Bergen, Passaic, Union, Middlesex, Monmouth, Morris, and Somerset counties in New Jersey, and Lower Fairfield county in Connecticut. The counties in New York State, New Jersey, and Connecticut chosen were those closest to the WTC site of the attacks and with a high proportion of residents who commuted to NYC. The adult population of this region was 15,802,925 in the 2000 US Census (Bureau of the Census, 2000). The sampling

frame was divided into four zones, radiating concentrically from the WTC sites with over-sampling of the zones closest to the site. All interviews were conducted by trained interviewers using a computer-assisted telephone interview system. Interviews were conducted in English, Spanish, and Chinese. Native English, Spanish, Mandarin, and Cantonese speakers administered the interviews (using translated questionnaires) in their respective languages. Surveys were approximately 35 minutes long and the measures used were consistent between surveys to allow for comparison. The overall cooperation rate was 56% and the response rate was 34%. Sampling weights were developed and applied to our data to account for the number of household telephones, persons in the household, and over-sampling. Further discussions of the methods and results from these surveys can also be found elsewhere (Galea *et al.*, 2002b, c; Vlahov *et al.*, 2002).

Survey instrument

Respondents were asked questions using a structured interview which assessed the mental health consequences of disasters (Freedy *et al.*, 1993). We asked questions about demographic characteristics (age, race/ethnicity, gender, yearly household income, education, and marital status), assessed proximity to the disaster site (south of 14th Street in this analysis; the WTC complex is in the south end of the borough of Manhattan and the area south of 14th Street is the area closest to the complex within NYC), and asked about September 11 event experiences including: if the respondent was in the WTC complex, was injured during the attacks, witnessed the attacks of September 11, was afraid for her/his life during the attacks, was displaced from home as a result of the attacks, if the respondent was involved in the rescue efforts, lost a job or possessions as a result of the September 11 attacks, and if friends or relatives were killed during the attacks. For the purposes of these analyses we combined the event exposure variables into a composite variable (referred to as being "directly affected" by the attacks) including: being in the WTC complex during the attacks, injured in the WTC attacks, having a friend or relative killed, losing possessions during the attacks, losing a job as a result of the attacks, or being involved in the post-disaster rescue effort (e.g., construction workers, doctors). We also assessed if the respondent reported experiencing symptoms consistent with a panic attack in the first few hours after hearing about the September 11 attacks. Symptoms of a peri-event panic attack were consistent with DSM-IV symptoms for panic attacks (American Psychiatric Association, 1994).

We used the NWS PTSD module to assess PTSD symptoms. The NWS was a large epidemiological research project carried out by the National Crime Victims' Research and Treatment Center (NCVC) at the Medical University of South Carolina that involved the assessment of national household probability samples of adult women about a variety of topics including history of traumatic events,

PTSD, major depression, and drug and alcohol use (Resnick *et al.*, 1993; Kilpatrick *et al.*, 1997). These assessments were made by telephone interviews over a 3-year period between 1989 and 1993. As part of this project, NCVS researchers developed and validated a diagnostic measure for PTSD and that was used in this work. The NWS PTSD module was validated in a field trial against the PTSD module of the Structured Clinical Interview for DSM-III-R (SCID; Spitzer *et al.*, 1992) administered by mental health professionals. The NWS PTSD module has been used in a number of RDD studies throughout the US (Hanson *et al.*, 1995; Kilpatrick *et al.*, 1997). In the field trial, inter-rater kappa coefficients for SCID based diagnoses were 0.85 and 0.86 for diagnoses of lifetime and current PTSD, respectively. In terms of comparison between the NWS PTSD module and the SCID, the kappa coefficient of the NWS PTSD module with SCID diagnosis of PTSD was 0.77 for lifetime PTSD and 0.71 for current PTSD. Instrument sensitivity was 99% and specificity was 79% when compared to SCID diagnosis (Resnick *et al.*, 1993; Kilpatrick *et al.*, 1998). Previous research using this measure among persons with a history of specific potentially traumatic events (e.g., rape, physical assault, or crime more generally) has shown that associations of these covariates with the PTSD were highly consistent with those reported in other epidemiological studies that carefully assessed both history of events and PTSD (Kilpatrick *et al.*, 1998), suggesting good construct validity for the NWS PTSD module.

The NWS PTSD module is a measure of PTSD that assesses the presence of Criterion B, C, and D symptoms and determines content for content-specific symptoms (e.g., content of dreams or nightmares) if symptom presence is endorsed. We measured PTSD symptoms and probable PTSD related to the September 11 attacks. We assessed probable PTSD since September 11 and current probable PTSD at the time of the survey based on prevalence of necessary PTSD Criterion B, C, and D symptoms since September 11 and within the previous 30 days, respectively. All re-experiencing symptoms (Criterion B) and all content-specific (e.g., avoidance of thoughts or feelings) avoidance symptoms (Criterion C) were required to be related to the September 11 attacks. Specifically, for each relevant content related PTSD symptom endorsed as being present for 2 weeks or more in the relevant time period, respondents were asked: "Was this related to the WTC disaster or to something else?" A subset of avoidance symptoms and all the arousal symptoms (Criterion D) could only be linked to the attacks by time frame (occurrence since September 11 or within the past 30 days). Participants were then required to report at least one re-experiencing symptom specific to the attack, at least three avoidance symptoms, and two arousal symptoms for a diagnosis of probable PTSD related to the September 11 attacks. Those reporting the combination of symptoms since September 11 or in the past 30 days were classified as having probable PTSD in the relevant time period.

Data presentation in this chapter

We present here prevalences of current probable PTSD and probable PTSD since September 11 as measured 6 months after September 11 for each of the key geographic areas in the NYC metropolitan area. These areas were: the boroughs of NYC (Manhattan, Brooklyn, Bronx, Queens, and Staten Island), the rest of New York State (NYS) (excluding NYC), New Jersey (NJ), and Connecticut (CT). We present the prevalence of each of the 17 DSM-IV PTSD symptoms and the prevalence of persons having sufficient symptoms to meet Criteria B, C, or D in the diagnosis of PTSD for the overall sample. We also present key bivariate relations between covariates assessed and the prevalence of probable PTSD since the September 11 attacks in the population sampled. We present variables that were significantly associated ($p < 0.05$) with probable PTSD since September 11 in two-tailed Chi-square testing. We used bivariate logistic regression analyses to determine odds ratios (OR) describing the relations between key covariate levels and probable PTSD.

Results

Characteristics of sample

Table 3.1 shows the demographic characteristics of the respondents interviewed for the entire sample and for the NYC subsample together with comparable data from the 2000 US Census to show similarity between the demographic estimates. Both the overall sample and the NYC subsample are statistically comparable to the population estimates from the US Census and do not suggest appreciable differences between the survey sampled and the underlying population.

Prevalence of probable PTSD in the NYC metropolitan area

The prevalences of probable PTSD in the different geographic regions of interest are shown in Table 3.2. Overall, 5.8% of respondents met criteria for probable PTSD in the aftermath of the September 11 attacks and 0.9% of respondents met criteria for current probable PTSD 6 months after September 11. The prevalence of probable PTSD after September 11 was highest in the NYC boroughs of Bronx, Brooklyn, and Staten Island (9.0% each for Bronx and Brooklyn, and 8.5% for Staten Island, compared to Manhattan prevalence of 7.7%). The prevalence of probable PTSD in these boroughs remained higher than that of other boroughs 6 months after September 11 (2.6% in Bronx, 2.4% in Brooklyn, 1.9% in Staten Island compared to 0.7% in Manhattan). The overall prevalence of probable PTSD since September 11 in NYC was 7.4% and the current prevalence 6 months after September 11 was 1.5%. The prevalence of probable PTSD in NYC was higher than that in the rest of NYS, NJ, or CT. In these three areas, the prevalence of probable PTSD since September 11 was 4.6% (NYS), 5.3% (NJ), and 1.1% (CT); current prevalence was 0.1% (NYS),

Table 3.1. Demographic characteristics of respondents surveyed 6 months after September 11 in the NYC metropolitan area compared to anticipated demographic characteristics based on the 2000 US Census ($n = 2752$)

Characteristics	NYC ($n = 1530$)		NYC metropolitan area ($n = 2752$)			
	Weighted percent from sample	Percent from 2000 US Census	Chi-square p -value	Weighted percent from sample	Percent from 2000 US Census	Chi-square p -value
<i>Age</i>						
18–24	14.7	13.2	0.58	13.6	11.7	0.69
25–34	27.0	22.5		23.7	20.4	
35–44	19.6	20.8		20.6	21.9	
45–54	18.3	16.7		19.0	17.7	
55–64	11.2	11.3		12.3	11.8	
65+	9.2	15.5		10.7	16.5	
<i>Gender</i>						
Male	44.1	46.2	0.67	46.3	46.9	0.90
Female	55.9	53.8		53.7	53.1	
<i>Race</i>						
White	35.8	38.7	0.51	55.4	54.8	0.80
African-American	23.7	23.0		15.8	16.5	
Asian	6.3	10.1		5.2	7.7	
Hispanic	28.7	24.7		19.6	18.5	
Other	5.5	3.6		4.0	2.6	

Table 3.2. Prevalence of probable PTSD in the NYC metropolitan area after September 11

	Probable PTSD after September 11	Current probable PTSD 6 months after September 11
Overall	5.8	0.9
Bronx	9.0	2.6
Brooklyn	9.0	2.4
Manhattan	7.7	0.7
Queens	4.6	0.3
Staten Island	8.5	1.9
NYC overall	7.4	1.5
New York State ^a	4.6	0.1
New Jersey	5.3	1.0
Connecticut	1.1	0.0

^aNew York State not including NYC.

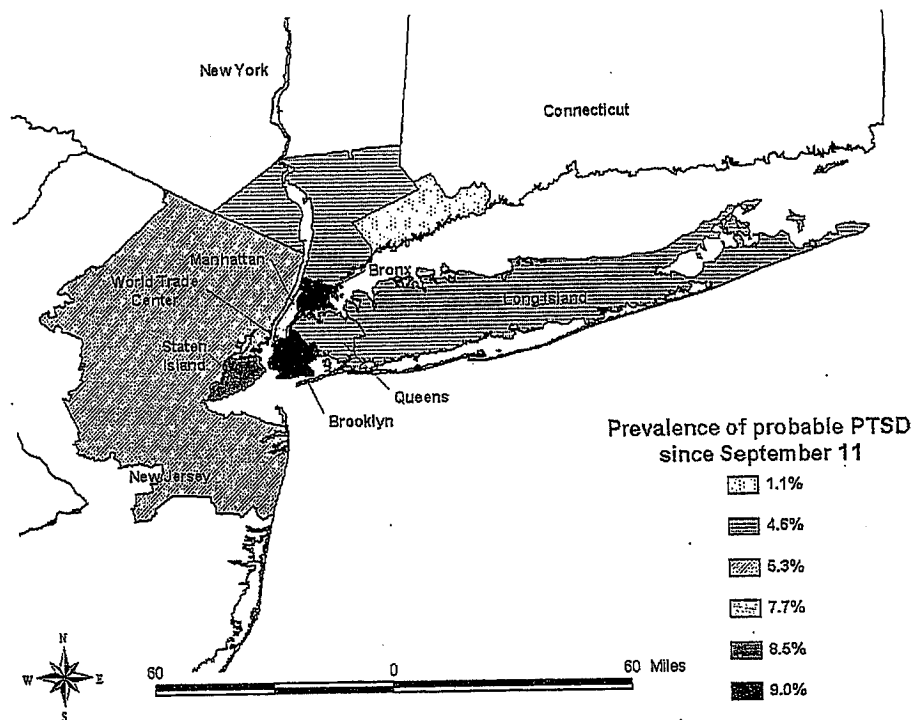


Figure 3.1 Geographic distribution of probable PTSD in the NYC metropolitan area.

1.0% (NJ), and 0.0% (CT) 6 months after September 11. Figure 3.1 illustrates the geographic distribution of the prevalence of probable PTSD since September 11.

Symptoms of PTSD in the overall sample

Twenty point four percent (20.4%) of respondents met re-experiencing symptom criteria (Criterion B), 9.9% of respondents met avoidance symptom criteria (Criterion C), and 20.7% met hyper-arousal symptom criteria (Criterion D) after the September 11 attacks. These prevalences had decreased to 8.9%, 3.9%, and 9.2%, respectively 6 months after the attacks. The most commonly reported symptoms after the September 11 attacks were insomnia (20.7%), irritability (17.4%), and intrusive memories (16.0%), and the most commonly reported symptoms 6 months after the attacks were insomnia (13.2%) intrusive memories (11.8%), and irritability (6.3%). Prevalences of PTSD symptoms since the September 11 attacks and 6 months after the attacks are shown in Figure 3.2.

Bivariate relations between demographic and event-exposure covariates and probable PTSD in the aftermath of the September 11 attacks in the NYC metropolitan area

Figure 3.3 shows socio-demographic variables that in bivariate analyses were significantly associated with the likelihood of probable PTSD since September 11 among

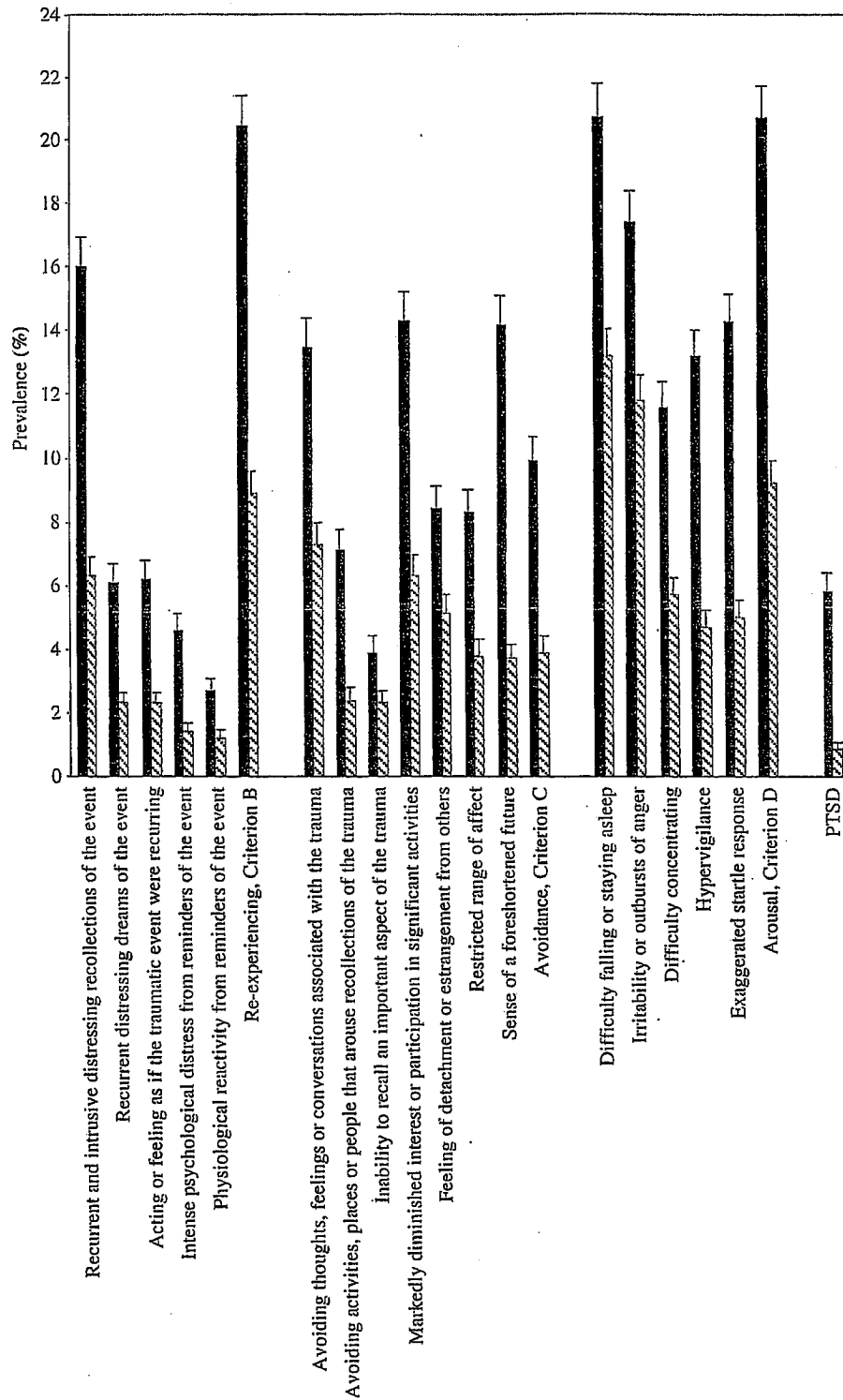


Figure 3.2 Prevalence of post-traumatic stress symptoms and of symptom criteria assessed in the NYC metropolitan area. Solid bars represent prevalence of symptoms since September 11 and the cross-hatched bars represent current symptoms, both measured 6 months after September 11.

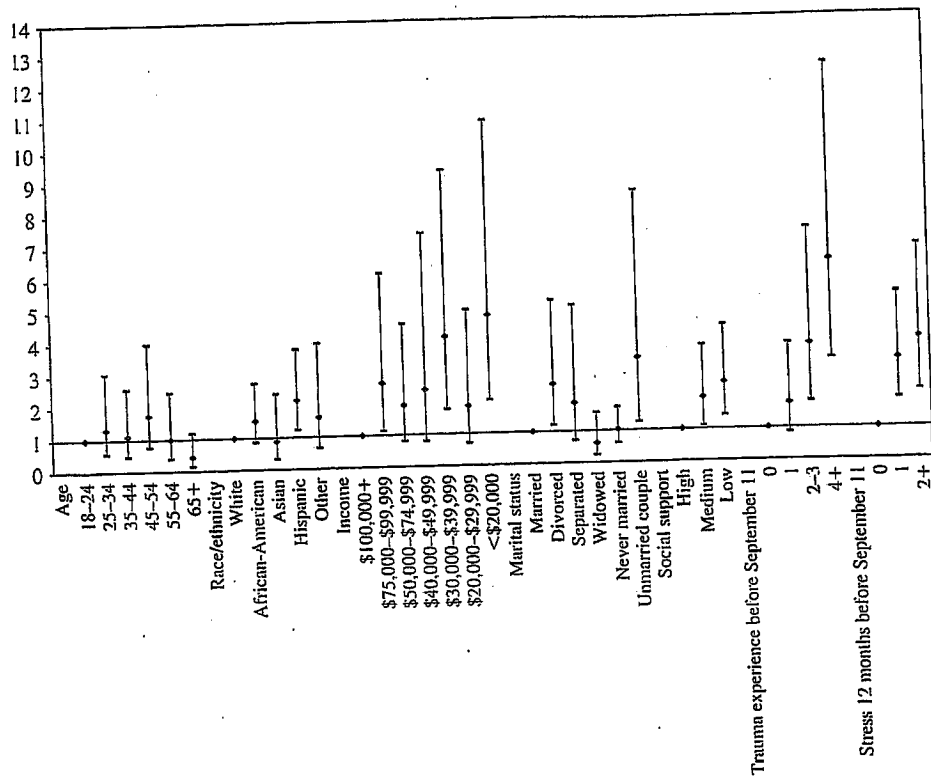


Figure 3.3 Odds Ratios describing the relations between key socio-demographic variables and probable PTSD in residents of the general population of the NYC metropolitan area assessed 6 months after September 11 ($n = 2752$).

residents of the NYC metropolitan area. Some of the variables that were associated with a higher likelihood of probable PTSD in the aftermath of September 11 in the NYC metropolitan area were: being Hispanic (OR = 2.15 vs. white referent), income (OR = 2.62 for annual income of \$75,000–\$99,999; OR = 4.06 for annual income of \$30,000–\$39,999; OR = 4.71 for annual income less than \$20,000; all compared to referent annual income of more than \$100,000), marital status (OR = 2.48 for persons who were divorced; OR = 3.27 for members of unmarried couples; both compared to married persons as referent), social support (OR = 1.99 for medium; OR = 2.46 for low social support; both compared to high social support as referent), lifetime traumatic event experience prior to September 11 (OR = 3.65 for previous experience of 2–3 traumatic events; OR = 6.30 for previous experience of four or more traumatic events; both compared to no prior traumatic event experience), and stressors in the 12 months prior to September 11 (OR = 3.16 for persons who experienced one stressor and OR = 3.82 for persons who experienced two stressors; both compared to persons with no stressors in the

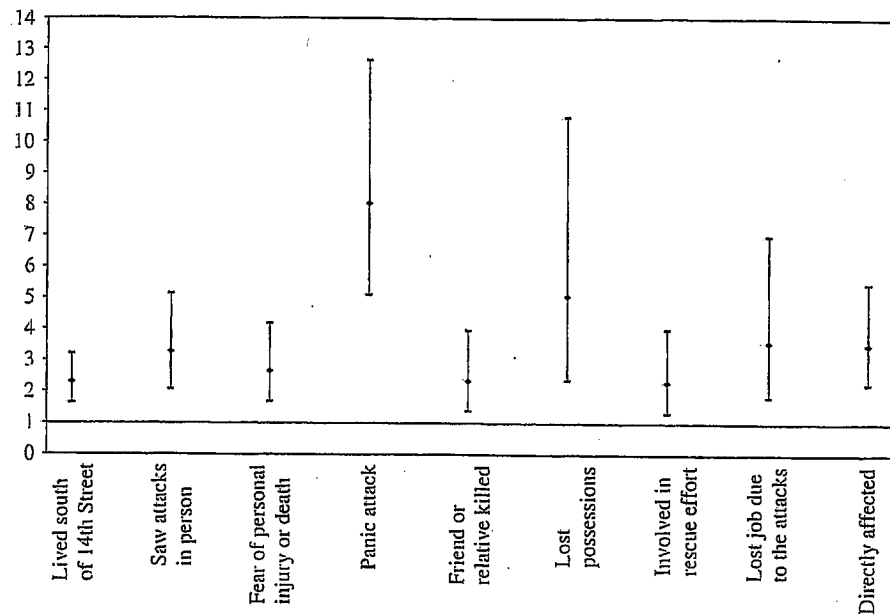


Figure 3.4 Odds Ratios describing the relations between event exposures and probable PTSD among residents of the NYC metropolitan area assessed 6 months after September 11 ($n = 2752$).

12 months prior to September 11). Figure 3.4 shows event exposure variables that in bivariate analyses were significantly associated with the likelihood of probable PTSD since September 11 among residents of the NYC metropolitan area. Event exposure variables that were associated with a higher likelihood of probable PTSD were living south of 14th Street, that is, in close proximity to the WTC (OR = 2.30), seeing the attacks in person (OR = 3.27); having been afraid of personal injury or death (OR = 2.66), experiencing a peri-event panic attack (OR = 8.03); losing possessions during the attacks (OR = 5.07), having been involved in the rescue efforts (OR = 2.31), and losing a job due to the attacks (OR = 3.59). Persons who were directly affected by the attacks (28.1% of overall sample) had 3.51 times greater odds of reporting symptoms consistent with probable PTSD since September 11.

Discussion

In the aftermath of a large man-made disaster in a densely populated urban area our work showed that there are symptoms of post-traumatic stress in the general population beyond those who are typically considered to be victims of such disasters. Consistent with previous work, we showed that persons who were more exposed to the disaster (e.g., persons who lived closer to the WTC complex, persons

who had a friend or relative killed in the attacks) were more likely to have symptoms consistent with PTSD after September 11. Overall, we estimated that persons directly affected by the attacks were 3.5 times more likely to have probable PTSD after the attacks than persons who were not directly affected by the attacks. However, we also showed that persons in the NYC metropolitan area who were not directly affected by the attacks also reported post-traumatic stress symptoms.

It is difficult to compare the absolute prevalence of probable PTSD documented here with prior research given both the uniqueness of the September 11 attacks and our focus on the general population. However, the preponderance of hyperarousal symptoms and of intrusive memories documented here are consistent with other post-disaster work (North *et al.*, 1999; McMillen *et al.*, 2000) and confirm our previous findings after this disaster (Galea *et al.*, 2002b). The geographic distribution of the prevalence of probable PTSD documented in this study was somewhat surprising, and an important reminder of the fact that multiple factors beyond proximity to the event determine the likelihood of psychopathology at the population level. We found that although Manhattan residents who lived closest to the WTC complex were more likely to develop probable PTSD after September 11, in the overall population, the prevalence of probable PTSD was highest in the boroughs of Brooklyn, Bronx, and Staten Island. This was true both for the development of probable PTSD since September 11 and for the current prevalence of PTSD as measured 6 months after the attacks. We conducted our earlier studies of PTSD after September 11 only in Manhattan due to our *a priori* assumption that the highest prevalence of PTSD would be in the borough where the WTC was located (Galea *et al.*, 2002a, b). However, this study showed that other factors beyond proximity are probably important in determining population prevalence of post-disaster psychopathology. It is likely that different factors contributed to the high prevalence of PTSD in Brooklyn, Bronx, and Staten Island. The former borough is to the east of Manhattan and residents of Brooklyn had probably the best views of the WTC complex from the attacks to the collapse of the towers. Also, Brooklyn is a predominantly commuter borough with residents of Brooklyn traveling to Manhattan for work on a daily basis. It is plausible that a combination of directly witnessing the event and being afraid of having friends or relatives killed in the attacks contributed to the high PTSD prevalence in Brooklyn. Staten Island is also a commuter borough and home to many of the rescue workers employed by the city police and fire departments. In contrast, the Bronx is a borough in northern NYC, further away from the WTC. However, the Bronx is predominantly Hispanic and our work has consistently shown Hispanicity to be a risk factor for the development of PTSD. Although it is likely a combination of factors that contribute to the higher prevalence of PTSD in these two boroughs compared to Manhattan, this observation serves to highlight the contribution of a complex set of variables to overall population prevalence in the aftermath of a disaster.

This relation between the individual risk of psychopathology and the population prevalence of psychopathology is interesting in this context, and has implications for public mental health planning in the aftermath of disasters. In this study, we estimated that 28.1% of respondents to this survey were, in some way, directly affected by the September 11 attacks. For the purposes of this analysis we used a very liberal definition of persons who might have been directly affected, with an eye to identifying as broad a range of persons as possible who may be conventionally referred to as "victims" of the disaster in one way or another. This group had odds 3.5 times higher than the rest of the respondents surveyed of developing probable PTSD related to the attacks. In the NYC metropolitan area that was the sampling frame for our work, we estimate approximately 4,440,000 persons directly affected by the attacks and 11,400,000 persons not directly affected by the attacks (Bureau of the Census, 2000). The net burden of probable PTSD in the former group would then be expected to be 500,000 and in the latter group 300,000 persons. While this calculation is meant to be merely illustrative and not a definite assessment of the number of people who had psychopathology, it demonstrates that the net burden of psychopathology in the aftermath of a disaster in a densely populated urban area may be at least as high among persons who are not directly affected by the disaster as it is among those who are. Calculations using different definitions about what constituted being directly affected by the attacks (e.g., different combinations of whether respondents saw events in person, lost relatives or friends, etc.) yield similar results. This discussion of the population burden of psychopathology is premised on two primary observations. First, although persons who are more exposed to an event are substantially more likely to have post-disaster psychopathology, this group is small relative to the general population. Second, the prevalence of post-traumatic stress symptoms in the general population of persons not directly affected by an event is not zero. As the general population is substantially larger than the group of persons who are directly affected, there is a substantial contribution from the general population to overall psychopathology. While the first of these observations is uncontroversial, the second is quite controversial. The DSM-IV diagnostic definition of PTSD requires that a person "experienced, witnessed, or was confronted with an event or events that involved . . . a threat to the physical integrity of self or others" (Criterion A1) and that the person have a subjective experience of "fear, helplessness, or horror" (Criterion A2). (American Psychiatric Association, 1995). On September 11 and during the difficult days afterwards there were many reasons for residents of the NYC metropolitan area to fear that their personal safety and that of others was under threat, to be confronted by the attacks, and to experience helplessness or horror, even if they were not directly affected on the morning of September 11. In the context of the September 11 attacks, persons who were not directly affected by the attacks may have been aware of the attacks through media, word-of-mouth, and communication with

friends or family who were present for the attacks and who subsequently suffered post-traumatic stress symptoms. Our results argue that these exposures, albeit indirect, may have been sufficient for "indirectly affected" residents of the NYC metropolitan to experience the attacks and to subsequently suffer substantial post-traumatic psychopathology.

We have previously documented the progression of probable PTSD in the NYC subsample of this survey. The progression of probable PTSD in the NYC metropolitan area reflects that in the larger area, as in the City, a substantial proportion of symptoms resolve spontaneously in the first 6 months after the event (Galea *et al.*, 2003). This is consistent with other work. For example, the National Comorbidity Survey showed a steep decline in PTSD symptoms in the first year after a traumatic event and remission of approximately two thirds of PTSD cases (Kessler *et al.*, 1995). Longer-term studies of the longitudinal course of PTSD, particularly among Vietnam veterans, also suggest that only a third of PTSD cases persist chronically (Kulka *et al.*, 1990; O'Toole *et al.*, 1996) and prospective studies of patients hospitalized due to a traumatic event, female rape victims, and persons who were affected by motor vehicle accidents have shown that more than half of the cases of PTSD remit in the first 3–6 months after onset (Shalev *et al.*, 1988; Rothbaum *et al.*, 1992; Blanchard *et al.*, 1996). However, of particular interest to the public health community are the persons who have persistent PTSD in the long-term. Extant research suggests that a substantial proportion of persons who continue to have PTSD 6 months after an event will have symptoms in the long term (Kessler *et al.*, 1995). Further longitudinal work is required to assess this after September 11. It is worth noting that the overall prevalence of probable PTSD documented here 6 months after September 11 was 0.9%. Although this prevalence is low, in the general population of the NYC metropolitan area this is equivalent to approximately 142,000 persons (and to 92,000 persons in NYC proper), a substantial proportion of whom may be expected to have long-term symptoms. This further highlights the long-term ramifications of disasters in densely populated areas.

We have previously commented on the role of specific covariates in relation to the development of probable PTSD in the aftermath of September 11 in Manhattan and in NYC (Galea *et al.*, 2002b, c). The observations reported here are largely consistent with those earlier findings and with the current literature. For example, our observation that marital status and social support were predictors of PTSD onset after September 11 is consistent with findings from other research (Boscarino, 1995; Bromet *et al.*, 1998; Brewin *et al.*, 2000) and suggests that in the general population specific groups may be at particular risk of psychological consequences of disasters and may warrant more focused screening. Our finding that peri-event emotional reactions may be an important predictor of PTSD suggests that early interventions to address these emotional reactions may have the potential to reduce the incidence

of PTSD after disasters (Resnick *et al.*, 1993). The importance of job loss highlights the complex relations between individual experiences (i.e., the job loss itself) and features of the recovery environment (i.e., the availability of jobs) and suggests that societal factors may be important determinants of symptom development after a disaster. The association of post-traumatic stress symptoms, substance use, and television viewing in this population are beyond the scope of this report and has been addressed elsewhere (Ahern *et al.*, 2002; Vlahov *et al.*, 2002; Vlahov *et al.*, in press).

Limitations

There are a number of limitations to this work in general and to this analysis in particular. Many of these limitations have been discussed in previous publications by this research team (Galea *et al.*, 2002a, b, c). We discuss briefly here some of the primary limitations of this work. Given the phone survey methodology and the lay-administered PTSD ascertainment instrument employed, case ascertainment and sampling bias are the two primary concerns with this work. With respect to the former, it is possible that since the NWS PTSD module is linked to event content only for content-specific symptoms, our probable PTSD prevalence is an overestimate of the true burden of psychopathology. There are two reasons why we think this is unlikely to be the case: (a) we have reported substantially lower prevalence of probable PTSD in the general population 1 month after September 11 than did the only other published representative population sample estimates of PTSD in NYC during the same time frame (Galea *et al.*, 2002b; Schlenger *et al.*, 2002); (b) a comparison between probable PTSD prevalence assessed using the PTSD Symptom Check List (PCL) and the NWS PTSD module, conducted on a subsample of 229 participants in survey 2, suggested that the NWS PTSD module provides a conservative estimate of the prevalence of probable PTSD compared to the PCL (Galea *et al.*, 2002d, Ruggiero *et al.*, in press). However, case ascertainment remains the primary limitation of assessments such as ours.

With respect to sampling bias, it is possible that our telephone sampling selectively sampled persons who were different than the rest of the population. Comparison of our sample to census demographic and socio-economic characteristics provides some reassurance in this regard. We note, however, that the response rate obtained in our study suggest that most people contacted in fact did not agree to participate in the survey. This is a problem endemic to all telephone surveys, irrespective of investigators' careful efforts to maximize response rates. There have been a number of recent observations that provide reassurance about the extent of sampling bias introduced in telephone surveys. Specifically, the RDD telephone survey method has also been routinely used to complete the CDC BRFSS which assesses risk behaviors in adults. A recent analysis of BRFSS data suggests that with changing response rates over the past 20–30 years have introduced minimal bias in data accuracy (Mariolis,

2001; Mariolis, 2002). Also, other work has shown that making extraordinary effort to reduce non-response in telephone efforts can in fact introduce bias in samples (due to the inclusion of respondents who are different than other non-responders) and that there are very few significant differences in key covariates over a range of reasonable response rates (Keeter *et al.*, 2000). In our surveys we were able to replicate our estimates of event exposure prevalence and symptom prevalence in each of the three surveys suggesting that only systematic sampling bias present in all three surveys is plausible. However, the potential for sampling bias remains. It is possible that persons with post-traumatic stress symptoms were less likely to participate in our surveys; this would suggest that our reported prevalence is an underestimate of the true burden of psychopathology in the general population. Conversely, if persons burdened by post-traumatic stress symptoms were more eager to talk on the phone it is possible that estimates presented here of probable PTSD represent overestimates.

Ultimately, it is worth noting that generalizability is a concern with this work. Although one of the prime motivations of this work was to provide reliable estimates of the population prevalence of PTSD after a disaster, the September 11 terrorist attacks in many ways were unique. Future terrorist attacks in the US are unlikely to be as unexpected as were the September 11 attacks. In addition, the September 11 attacks were accompanied by other ongoing events (e.g., the anthrax threats) that make the post-September 11 context unique. At best the burden of psychopathology estimated here can then serve as a guide as to what may be expected after other disasters in densely populated urban areas.

Directions for future research

This work encourages research in four areas. First, this research has been among the few to study PTSD in the general population starting immediately after a disaster. Soon after we published the first assessment of PTSD in the general population after September 11 (Galea *et al.*, 2002b), other authors (Cohen Silver *et al.*, 2002; Schlenger *et al.*, 2002) published work premised on similar assumptions to the ones we made and discuss here (although methods used, particularly by Cohen Silver and colleagues were substantially different than ours). Results, particularly from Schlenger and colleagues' study (Schlenger *et al.*, 2002) were similar to ours, providing further credence to some of the issues that we raise here about the implications of our observations for public health and for our conceptualization of PTSD. Therefore, a primary area of research that is encouraged by this work is the study of the impact of large-scale disasters in densely populated urban areas on the general population. As discussed above, this has substantial implications for public health practice and for our understanding of the burden of PTSD in a population. In addition, better understanding of the differences in the nature of PTSD between persons who are heavily, and less heavily affected by a disaster may also shed insight into the biology of PTSD.

Second, this research points the way to more focused work to explore the longitudinal course of PTSD in the general population after disasters. Although, as discussed in this chapter, the research implemented through the NYAM studies made use of a serial cross-sectional design to study the course of PTSD in the general population, a more explicit exploration of many of the observations that are emerging from this work (Galea *et al.* 2003b) is only possible through longitudinal studies. In addition, longitudinal studies can assess the course of PTSD in the general population in the longer term, and whether the currently accepted dogma that most cases of PTSD after disaster arise in the immediate short term is valid in a study of the general population.

Third, this work points to the need for further research about peri-event emotional reactions, and the extent to which interventions that target these emotional reactions (particularly among different racial/ethnic groups) may be effective in reducing incident PTSD. We showed in this chapter and in other work (Galea *et al.*, 2002b, c) that peri-event panic attacks were among the most important predictors of probable PTSD onset and that these emotional reactions may be differently important for persons of different ethnicities (Galea *et al.*, unpublished data). These observations point to the importance of a better understanding of the determinants of PTSD and highlights our current paucity of understanding of PTSD cross-culturally and cross-nationally. Future research on PTSD must include cross-national and cross-cultural comparisons that have the potential both to illuminate the true global burden of PTSD and also to suggest differences in pathophysiology that can lead to greater biological understanding and the potential for preventive interventions.

Fourth, our work suggests the need for further research that considers the implications of the range of possible exposures to disaster both for the diagnosis of PTSD and for public mental health interventions in the general population. With respect to the diagnosis of PTSD, further work is needed to understand the range of exposures in the general population of densely populated urban areas after disasters, and to corroborate our observations about the importance of PTSD in the general population in the aftermath of disasters. Future studies need to consider the range of services that are needed in the general population after a disaster, especially among specific subgroups (e.g., Hispanics) within the general population that may be particularly vulnerable to the development of PTSD.

Implications for mental health intervention in the post-disaster setting

In the aftermath of disasters limited resources for research and care have resulted in a focus on persons who are at highest risk of developing psychopathology. This study, like others before it, identified persons who were directly affected by the event as being at greater individual risk of PTSD. Here, we also confirm our earlier reports that Hispanicity and the presence of a peri-event emotional response are important determinants of PTSD that must be considered in conjunction with other, better

established risk factors such as prior life stressors. However, studying the general population of the NYC metropolitan area shows the complex relation between individual risks and the ultimate population burden of psychopathology post-disaster. Clearly, public health practice must concern itself not only with persons who are high risk, but also with the larger population of persons who may be at low risk but may still develop post-traumatic symptoms. In the aftermath of a major disaster in a densely populated urban area it is possible that there may be more persons in the low-risk group who require attention than there are in the high-risk group. Unfortunately, this does not make public health intervention in the aftermath of a disaster easier. In many ways, it is easier to target persons who are directly affected for intervention (e.g., relatives of family members who die in a disaster are likely to be involved in support groups) than persons in the general population who otherwise share few risk factors. This highlights the importance of extensive general population outreach to people not otherwise connected to the post-disaster infrastructure. Recent work showing the difficulty in reaching persons through public health announcements (Rudenstine *et al.*, 2003) and the scope of unmet mental health need (Kessler *et al.*, 2001) suggests that this is not easily done. In that light, innovative early post-disaster interventions that may be easily accessed by the general population may be particularly important after future disasters.

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