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Social and psychological resources and health outcomes after the World Trade Center disaster

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Abstract

Previous studies on community disasters tend to assess non-representative samples and use nonstandard measures of well-being. Additionally, few of these studies are longitudinal in design. In this report, we examine the consequences of the World Trade Center Disaster (WTCD) within a stress model perspective to assess level of exposure to the disaster and well-being after this event, as measured by the SF12 mental health and physical health scales. Data come from a two-wave panel study of 1681 English or Spanish speaking adults living in New York City on the day of the terrorist attacks and were collected by telephone interviews 1 and 2 years after the disaster. In ordinary least-squares regression models that contained demographic characteristics, stress risk factors, and social psychological resources as independent variables, level of exposure to the disaster was associated with poorer Wave 2 physical well-being, but not psychological health. Level of disaster exposure was not related to Wave 2 physical health, however, once the Wave 1 level of physical health was controlled, suggesting that disaster exposure did not have a lasting impact on variation in physical well-being. Results also indicated that experiencing a panic attack, negative life events, or traumatic events were related to poorer physical health. Respondents who met screening criteria for possible alcohol dependence post-disaster, experienced negative life events, or experienced traumatic events, were more likely to suffer from poorer mental health compared to those who did not meet the criteria, experience negative life events or experience traumas. We discuss these findings relative to community disasters in industrialized and developing countries.

Keywords

Community disasters; World Trade Center disaster; Psychological well-being; Stress and coping; United States

Introduction

Recently, studies have focused on exposure to community disasters as a specific type of stressor and factors that can intensify or diminish the effects of such stressful events on individuals (Adams et al., 2002; Bromet, Gluzman, Schwartz, & Goldgaber, 2002; Havenaar et al., 1996; Norris et al., 2002). Although some researchers have contended that persons recover quickly from these experiences (e.g., McFarlane, 1988, 1989), reviews of disaster studies have concluded that large-scale community traumas can result in a significant increase in

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psychological problems in the short-term and can have significant negative physical and mental health consequences for years post-disaster (Brewin, Andrews, & Valentine, 2000; Bromet & Dew, 1995; Rubonis & Bickman, 1991).

More specifically, research on community disasters has suggested that survivors of these events evidence increases in psychological problems (e.g., posttraumatic stress disorder (PTSD), depression, and anxiety), health problems and concerns, chronic problems in living, and psychosocial resource losses (Adams et al., 2002; Bromet & Dew, 1995; Norris et al., 2002). Among direct survivors of the Oklahoma City bombing (North et al., 1999), for example, 45% had post-disaster psychiatric disorders and 34% had PTSD. Studies after the Chornobyl nuclear accident found that psychological distress and complaints of physical problems were significantly more prevalent among residents living near the plant when it exploded compared to those from areas further away as long as 11 years after the accident (Adams et al., 2002; Bromet et al., 2002; Havenaar et al., 1996).

Based on psychosocial stress theory (Pearlin, Lieberman, Menaghan, & Mullen, 1981; Thoits, 1995), other aspects of survivors' lives can strengthen or weaken their ability to cope with a community disaster. More specifically, demographic characteristics such as socioeconomic status or gender, other life events experienced by survivors (e.g., death of a spouse), and social psychological resources (e.g., self-esteem) can add to or reduce the distress levels of individuals undergoing a traumatic event (Pearlin et al., 1981; Thoits, 1995; Norris et al., 2002). Generally, women, people of color, parents, and the poor are more likely to suffer psychological difficulties after a community disaster when compared to men, Whites, childless individuals, or the wealthy (Brewin et al., 2000; Norris et al., 2002). Community disasters may overwhelm individuals who suffer from other negative life events or traumas, or have a history of psychological problems (McFarlane, 1989; Norris et al., 2002). In their study of the consequences of the Exxon Valdez oil spill on people living in communities along Prince William Sound, for example, Palinkas, Downs, Petterson, and Russell (1993) found that although the spill itself was not particularly life threatening, it disrupted subsistence food production (e.g., fishing), strained family and community relationships, and increased social inequality, all of which led to increased social tensions, drinking, and domestic conflicts. Individuals living in communities most affected by social changes related to the spill and clean-up efforts also reported greater psychological problems and somatic complaints.

Disaster studies have, however, been subjected to a number of criticisms. Many of the samples studied have been small and not representative of the affected community's population (Bromet & Dew, 1995). For example, North et al. (1999) used a confidential registry of survivors from the Oklahoma City Bombing. Even though the sample was representative of the registry, the authors note that it overrepresented individuals who were close to the blast and was, therefore, not representative of Oklahoma City's population. In addition, researchers have not always used standardized mental or physical health measurement instruments or employed an explicit model to guide the selection of individual or social factors which may moderate the effects of the disaster (Bromet & Dew, 1995). Finally, previous studies of the WTCD have followed community residents for a short period of time and have been mostly cross-sectional (Boscarino, Adams, & Figley, 2004; Boscarino, Galea, Ahern, Resnick, & Vlahov, 2002; Boscarino et al., 2004; Galea et al., 2002, 2003).

In earlier reports about the World Trade Center Disaster (WTCD), researchers reported psychological difficulties consistent with previous research. A study conducted one month after the attacks found that 7.5% of adults living in Manhattan close to the WTC had symptoms consistent with PTSD related to these attacks and 9.7% had symptoms consistent with depression (Galea et al., 2002). Although studies conducted 4 and 6 months post-disaster revealed a decline in PTSD and depression (e.g., Galea et al., 2003), they also indicated a

sustained increase in substance use (Vlahov et al., 2002; Vlahov, Galea, Ahern, Resnick, & Kilpatrick, 2004). Finally, our own study conducted 12 months after attacks showed that residents of New York City (NYC) who experienced more WTCD events were more likely to report lower well-being, were more likely to suffer from depression and PTSD, and reported greater use of mental health services and psychotropic medications compared to the less exposed (Adams and Boscarino, 2005; Boscarino, Adams, et al., 2004).

In the present study, we extend our previous investigations on the consequences of a community disaster, using longitudinal data to assess the association between level of exposure to the WTCD events and the psychological and physical well-being of NYC residents. These data allow us to address the question of whether adverse consequences of exposure to the WTCD found one year after the attacks persisted. In addition, longitudinal data also allows us to time-order our independent variables relative to the dependent variables. Finally, we assess a "stress-vulnerability" hypothesis, whereby exposure to WTCD events increases the vulnerability of residents to other life events and social stress. Community disasters can result in a cascade of negative life and traumatic events and increase chronic strains, such as financial problems (Adams et al., 2002). The vulnerability hypothesis stipulates that higher exposure to WTCD increases the reactivity of survivors to these other negative events and thereby decreases well-being, above and beyond the cumulative effect of the individual stressors (Dohrenwend & Dohrenwend, 1981).

World Trade Center disaster

The terrorist attacks in NYC on September 11, 2001, resulted in one of the largest death tolls of any disaster in the United States (Centers for Disease Control, 2002). Approximately 2800 persons died, with thousands injured and many residents directly witnessing the events. In addition, a large area of lower Manhattan's business district was destroyed, resulting in further social and economic hardships. The scope of the September 11 attacks and their impact on the local community in the weeks that followed suggested that these events might have significant long-term consequences for mental and physical health. Indeed, early post-disaster research already documented a high prevalence of psychological symptoms and disorders among residents of NYC, as noted above (Boscarino et al., 2002; Galea et al., 2002).

For this study, we had several research questions. First, did exposure to the events associated with the WTCD have a negative association with well-being 2 years after the attacks, controlling for other risk factors? Second, did level of exposure relate to negative life events and traumas 1–2 years after the attacks? That is, did individuals who experienced more WTCD events also report more adverse events after the disaster? Third, was exposure related to a decline in well-being between W1 and W2? Finally, did exposure increase the reactivity or vulnerability of survivors to trauma and negative life events post-WTCD?

Data and methods

The data for the present study come from a two-wave panel study of English or Spanish speaking adults. For wave 1 (W1), we conducted a telephone survey, using random-digit dialing, a year after the attacks. Potential participants had to be living in NYC at the time of the study and at the time of the attacks. The population was also stratified by the 5 NYC boroughs and gender, and then sampled proportionately. When interviewers reached a person at a residential telephone number, they obtained verbal consent and then ascertained the area of residence in NYC, screening out nonresidents and those who were not living in NYC on September 11, 2001. Interviewers then determined the number of adults in each household and selected one for an interview based on the adult with the most recent birthday, if more than one eligible adult lived in the household. Interviews occurred between October and December

2002. Since part of the overall study was to evaluate healthcare service utilization, we over-sampled residents (by about 85%) who reported receiving any mental health treatment in the year after the attacks, identified by means of screener questions at the beginning of the survey. Questionnaires were translated into Spanish and then back-translated by bilingual Americans to ensure the linguistic and cultural appropriateness of the survey items. For the psychological and physical health outcome measures to be discussed, we used the current Spanish language versions of these measures available from the instrument developers.

For wave 2 (W2), we attempted to re-interview all W1 participants one year later (i.e., 2 years after the WTCD). All interviews occurred between October 2003, and February 2004. The procedures were the same as those used in W1. For both waves, trained interviewers using a computer-assisted telephone interviewing system conducted all of the interviews. All interviewers were supervised and monitored by the survey contractor in collaboration with the investigative staff. A protocol was in place to provide mental health assistance to participants who required psychiatric counseling. The duration of the interviews was about 45 min for W1 and 35 min for W2. The Institutional Review Board of the New York Academy of Medicine reviewed and approved the study's protocols.

Overall, 2368 individuals completed the W1 survey and 1681 completed the W2 survey. Approximately, 7% of the interviews were conducted in Spanish for W1 and 5% for W2. Using industry standards for survey data collection (American Association for Public Opinion Research, 2000), the W1 cooperation rate was approximately 63%. More specifically, the cooperation rate was composed of (1) completed interviews, (2) screen outs—respondents who were not living in NYC at the time of the interview, were not living in NYC on September 11, or did not speak English or Spanish, (3) quota outs—respondents who were eligible to be interviewed but were a gender or lived in a borough where the required number of interviews had been completed, and (4) refusals (cooperation rate = completed interviews [2369]+screen outs [4985]+quota outs[117]/completed interviews+screen outs+quota outs+refusals [4330]). Our response rate, which is based on completed interviews divided by all eligible phone numbers and refusals, was 37% (completed interviews [2368]/quota outs [117]+refusals [4330] +residential phone but not interviewed by end of data collection [1945]). This response rate is comparable to other studies of the WTCD (e.g., Galea et al., 2002, 2003). The re-interview rate for W2 was 71%.

For both waves, sampling weights were developed to correct for potential selection bias related to the number of telephone numbers and persons per household and for the over-sampling of treatment-seeking respondents. Over-sampling and survey weighting to adjust for this (which are based on the inverse of the probability of selection) are common in survey research and function to increase survey data for subpopulations of interest (e.g., minority respondents, etc.), while at the same time reducing measurement errors for these subpopulations (Groves et al., 2004). In addition, as discussed below, demographic weights also were used for W2 data in order adjust for slight differences in response rates by different demographic groups, as is common practice in panel surveys (Kessler, Little, & Groves, 1995). Combined these weights allow us to treat the sample as representative of residents living in NYC on the day of the terrorist attacks (Groves et al., 2004).

Dependent variables

For both waves, physical health and psychological health were assessed using the Short Form-12, version 2 (SF-12-v2). The SF-12-v2 consisted of 12 items scored so that high scores reflect better health. Following the recommended scoring algorithms given by Ware, Kosinski, Turner-Bowker, and Gandek (2002), the items were converted into T-scores, multiplied by a weight factor developed from the national sample, and summed to form the mental health or physical health component scores. This algorithm was designed so that both scales would have

scores with a mean close to 50, a standard deviation close to 10, and be uncorrelated with each other. Although both scales contain all 12 items, the physical health measure (SF-12-v2 physical component, W1 range 10–70; W2 range 8–69) emphasized physical functioning, role functioning, body pain, and general health status over the past 30 days. The psychological health measure (SF-12-v2 mental component, W1 range 7–74; W2 range 11–74) emphasized vitality, social functioning, emotional functioning, and mental health status over the past 30 days. (See Ware et al. (2002) for a more detailed discussion of this scoring algorithm.) The SF-12-v2 scale has good reliability and validity, correlates well with clinical assessments of physical and mental health (Ware et al., 2002), and has been used in numerous studies worldwide (e.g., Burdine, Fleix, Able, Wiltraut, & Musselman, 2000; Fleishman & Lawrence 2003; Ware, Kosinski, & Keller, 1996).

Independent variables

Background characteristics—The analyses included seven demographic variables collected during the W1 interview: age, education, children in the home, gender, marital status, ethnicity, and income. Age was coded to the nearest year. Education, children in the home, gender, marital status, and self-reported race/ethnicity were dummy coded, with less than college graduate, no children under 18 in the home, male, not married, and white the reference categories. We coded income into 7 categories, including under $20,000, $20,000–$29,999, $30,000–$39,999, $40,000–$49,999, $50,000–$74,999, $75,000–$99,999, and $100,000+ and included this in our analyses as a continuous variable (coded 1–7). We replaced missing data for these demographic characteristics with data from W2, where possible. Approximately, 3% of respondents still had missing data for income. We substituted the mean income category (coded 4) for these respondents. For all other missing on the demographic factors, we deleted listwise.

Stress risk factors—Our analyses also examined five stressors or variables, which could have placed the individual at risk for poor psychological and physical well-being. Two of the measures were from the W1 survey (WTCD exposure and panic attack) and three were from the W2 survey (negative life events, traumatic events, and screening for alcohol dependence). WTCD exposure was the sum of 14 events that the responded could have experienced (yes; no) during the attacks (e.g., fear of being killed, friend or relative killed, forced to move, lost job as a direct result of the WTCD). Since there was not an *a priori* reason to assess the severity of any individual exposure event, we decided that a simple summation of events experienced by the respondent was the best way to measure this stressor.[1] Owing to its skewed distribution, though, we recoded individuals reporting 9 or more events to a score of 8. The survey also assessed whether or not the person met criteria for having a panic attack during the year between the WTCD and the W1 survey. This measure is a modification of the Diagnostic Interview Schedule (DIS) version (Robins et al., 1999), phrased to assess perievent symptoms that occurred during or shortly after a traumatic event (American Psychiatric Association (APA), 1994). Consistent with DSM-IV criteria (APA, 1994), the presence of four or more symptoms which reached their peak within 10 min of onset classified the person as having a panic attack and was coded 1. Not meeting criteria was coded 0. The W2 negative life event scale was the

[1]Specifically, the exposure measure inquired about the following events: (1) R was in the WTC at the time of the attacks, (2) R saw in-person or on TV the disaster while it was happening, (3) R heard or felt impact of plane into WTC, (4) R feared being killed during the disaster, (5) relatives of R were killed or injured during the disaster, (6) friends of R were killed or injured during the disaster, (7) acquaintances of R were killed or injured, (8) R had difficulty breathing because of smoke or debris during the disaster, (9) R lost possessions or had possessions damaged as a result of the disaster, (10) R was injured as a result of the disaster, (11) R was involved in the rescue or recovery efforts after the disaster, (12) R was involved in other ways helping those affected by the disaster, (13) R had to move out of home due to the disaster, (14) R lost job due to the disaster. Past studies of the WTCD indicated that most of these 14 experiences, individually, were related to PTSD or depression (Galea et al., 2003). In addition, they cover most of the dimensions identified by Bromet and Dew (1995) as important for understanding how community disasters impact survivors. Thus, a simple summation appeared to be an appropriate strategy for distinguishing residents of NYC who experienced varying levels of trauma due to the WTCD.

sum of eight experiences that the respondent could have had in the previous 12 months (e.g., divorce, death of spouse, problems at work, etc.) and was based on previous research (Freedy, Kilpatrick, & Resnick, 1993). Based on an examination of the frequency distribution, we categorized respondents into three groups (no life events, one life event, and two or more life events) and created two dummy variables, with no life events the excluded category. The traumatic events measure focused on 10 traumatic events which could have occurred in the 12 months prior to the W2 interview (e.g., forced sexual contact, being attacked with a weapon, serious accident) and was also based on previous research (Freedy et al., 1993). Again, based on an examination of the frequency distribution, we coded respondents into no traumatic events, one traumatic event, and two or more traumatic event groups and created two dummy variables, with no traumatic events the excluded category. Finally, the W2 survey also inquired about the respondent's consumption of alcoholic beverages using the CAGE questionnaire, a four-item screener for alcohol dependence (Cherpitel 1999;Magruder-Habib, Stevens, & Alling, 1993). This widely used and validated scale correlated well with a clinical diagnosis of alcoholism and has been used in a variety of clinical and population surveys (Ewing, 1984;King, 1986). Following CAGE criteria, we defined screening criteria for alcohol dependence as a positive response on 2 or more items (e.g., criticized about drinking, drank first thing in the morning, etc.) for the 24 months after the WTCD, with not meeting screening criteria the reference group. The WTCD exposure, negative life events, traumatic events, and panic attack measures were used and validated in other WTCD studies in NYC (Boscarino et al., 2002;Boscarino, Galea et al., 2004;Galea et al., 2002,2003).

Social psychological resources—The last set of variables in our analyses included one social and one psychological resource variable from the W1 survey. According to psychosocial stress theory, these resources can reduce the effect of stressful events on well-being (Pearlin et al., 1981). The W1 social support scale (Sherbourne & Stewart, 1989) was the sum of four questions about emotional, informational, and instrumental support (e.g., someone available to help you if you were confined to bed). These items were coded so that higher scores indicated higher social support and used as a continuous variable (Cronbach's alpha W1 = .83; W2 = .82). The support scale had good validity and reliability in previous research and used extensively in other WTCD studies in NYC (Boscarino, Adams et al., 2004; Boscarino et al., 2002; Boscarino, Galea et al., 2004; Galea et al., 2002). W1 self-esteem was based on the Rosenberg's self-esteem scale (Rosenberg, 1979), a widely used and validated scale (Blascovich & Tomaka, 1991). Our measure was the sum of five items in the original scale (e.g., I certainly feel useless at times; On the whole, I am satisfied with myself) and was scored so that higher values indicated higher self-esteem (Cronbach's alpha W1 = .73, W2 = .77). We used this scale in earlier research and demonstrated that it was strongly related to PTSD, depression, and W1 SF12-physical health and mental health in the expected directions, suggesting concurrent validity (Adams & Boscarino, 2005; Boscarino, Adams et al., 2004). Thus, this measure appeared to be a valid and reliable measure of self-esteem.

Statistical analysis

We first assess whether or not the W1 sample matched the population of NYC and whether or not the W2 sample matched the W1 sample. We also conducted attrition analyses. Next, we present the basic descriptive statistics for the W1 and W2 variables used in the present analyses, along with the Pearson correlation coefficients among the dependent variables and the exposure, negative life event, and trauma independent variables. An examination of frequency distributions and bivariate scatterplots (not shown) indicated no significant violation of the assumptions underlying liner models. Next, we estimated ordinary least-squares (OLS) regressions to predict physical and mental health outcomes, respectively, from personal characteristics, stress risk factors, and resource variables. The regression analyses proceeded in three steps to assess how each set of variables increased the model's explanatory power.

Model 1 estimated the association between the demographic variables and the dependent variables. Next, we included the stress risk and resource factors in the equation (Model 2). These results revealed the unique effects of the independent variables, controlling for other variables in the model. The final model adds the W1 measure of the W2 outcome (Model 3). That is, for the W2 SF-12-v2 physical health dependent variable, model 3 includes all of the demographic, stress, resource, and W1 SF-12-v2 physical health. This final model assesses the extent to which W2 physical and mental health can be predicted by the demographic, stress, and resource variables, controlling for their initial W1 level. This multivariate method of analyzing change over two time points is more appropriate than other statistical techniques (Cohen & Cohen, 1983, pp. 413–423). Although recent work argues that three or more waves are necessary to actually assess the nature of the change (e.g., Singer & Willett, 2003), our goal is more limited in that we wish to assess the association between the WTCD and well-being 2 years after the attacks, controlling for the earlier W1 level of well-being.[2]

Following recommendations by Aiken and West (1991), we tested interaction terms for exposure to the WTCD and all of the other independent variables in order to assess the vulnerability hypothesis. Due to the large number of interaction terms, we estimated three separate models with interactions for demographic factors tested first, stress/risk examined second, and resource variables assessed in a third equation. In addition, given that some research has found that women with children in the home are more vulnerable to environmental stressors (e.g., Bromet, Parkinson, Schulberg, Dunn, & Gondek, 1982), we examined a fourth model with interaction terms for gender and all stress/risk and social psychological resource variables.

Lastly, we follow the procedure recommended by Baron and Kenny (1986) to test whether W1 well-being mediates the association between WTCD exposure and W2 well-being. The steps for this require that: (1) The effect of WTCD exposure on W2 SF12-physical health or W2 SF12-mental health is significant; (2) the association between WTCD exposure and W1 SF12-physical or W1 SF12-mental health is significant; (3) the relationship between W1 and W2 SF12-physical health or between W1 and W2 SF12-mental health is significant; (4) for complete mediation, requires that WTCD exposure no longer has any effect on the W2 SF12-physical or W2 SF12-mental health, when W1 SF12-physical health or W1 SF12-mental health is controlled.

We used the survey estimation (svy) command set in Stata, version 7 (Stata Corporation, 2001) to generate frequency distributions and OLS regression models. This estimation procedure adjusted the data for our sampling design, which included stratification by city borough and gender and, as noted earlier, case weights.

Results

An analysis comparing the weighted W1 sample and Census data for NYC (Table 1) indicated no differences for age, gender, race, or NYC Borough. Thus, the W1 sample appeared to be representative of NYC and was not demographically biased due to the cooperation rate or sample selection. When we compared responders for the W2 sample to non-responders (unweighted), we found some demographic differences, with Whites, older respondents, and women more likely to participate in the W2 survey. These results are not uncommon for panel

[2]Recently, there has been some discussion about analyzing change using lagged-dependent variables, or residual change analysis (Singer & Willett, 2003). These researchers contend that a difference scores (W2–W1 scores on the variable) have fewer technical flaws. We performed additional analyses re-estimating model 3 with a difference score as the dependent variable. For example, we used the difference between W2 SF-12 physical health and W1 SF-12 physical health as the dependent variable, rather than W2 SF-12 physical health as the dependent variable controlling for W1 SF-12 physical health. The results of these analyses for both outcome measures are essentially the same for exposure to WTCD events, negative life events, traumatic events, social support, and self-esteem (available upon request).

surveys (Kessler et al., 1995). Consequently, to correct for this potential bias, we adjusted our W2 data for these differences using sampling weights derived from W1 data, which is often the recommended method (Kessler et al., 1995). As shown (Table 1), a weighted comparison between the W1 and the W2 samples revealed no differences between them and thus showed that the weights corrected for differing participation rates for these four demographic variables.[3] Finally, we compared survey responders to non-responders for our two outcome measures and the two psychosocial resource variables. These analyses indicated that responders were no different from non-responders on the SF12-physical health component, but were different on the SF12-mental health component, social support scale, and self-esteem scale. Specifically, responders tended to have slightly better psychological health, social support, and self-esteem than non-responders, even after weighting the data.

Other characteristics of the sample are shown in Table 2. As found in previous WTCD studies (Boscarino, Galea et al., 2004;Galea et al., 2002), compared to other areas of the US, residents of NYC are educated, with more than 40% having a college degree, and more highly paid with over 16% making $100,000 or more. About 50% were married or living together and over 40% had children under 18 living in the household. In terms of exposure to stressful events, almost 75% of the respondents reported two or more WTCD related events, about 50% reported at least one negative life event in the past year, and 16% reported at least one traumatic event in the past year. We highlight the fact that almost 5% met the CAGE screening criteria for alcohol dependence in the 2 years between the WTCD and the W2 survey and that 10% met criteria for panic attack in the W1 survey.

Examining the Pearson correlation coefficients among WTCD exposure, W2 negative life events, W2 trauma, and W2 screening positive for alcohol dependence indicated that exposure was statistically related to all three of these stress/risk variables (r = .22, .15, .10, respectively). Interestingly, exposure was not correlated with either W1 or W2 SF12-physical health (r = .00, −.02, respectively), but was associated with both W1 and W2 SF12-mental health (r = −.19, −.15, respectively). Finally, W1 SF12-physical health was highly associated with W2 SF12-physical health (r = .69) and W1 SF12-mental health was highly related to W2 SF12-mental health (r = .55).

The multivariate results for the SF12-v2 physical health (Table 3) revealed that demographic characteristics as a block of variables explained 24% of the variation in this outcome (Model 1). As can be seen, older respondents, African Americans, Latinos, and Other racial groups had poorer physical health than younger and White respondents, while educated respondents and those with higher incomes had better physical health. Having children in the home, female gender, and married status were not statistically significant. Adding the stress risk and social psychological resource variables (Model 2) increased the R^2 to .28. All of the significant demographic variables from Model 1 remained statistically significant in this model, except for respondents in the Other race/No race reported category. Interestingly, the more exposure to events related to the terrorist attacks, the lower a person's physical health, 2 years after the WTCD. In addition, individuals meeting criteria for a panic attack at W1 were also more likely to exhibit poorer physical health relative to those who did not meet criteria. Finally, those who reported negative life events in the past year had worse SF-12-v2 physical health outcomes. Traumatic events in the past year were not statistically related to physical health.

The final model (Model 3) explicitly tested the ability of the independent variables to predict W2 physical health after accounting for its level at W1. As expected, controlling for W1 SF-12-

[3]Other attrition analyses showed that W2 responders did not differ from non-responders for WTCD exposure, drinking behavior, self-esteem, negative life events, trauma, post-WTCD mental health treatment seeking, meeting criteria for lifetime PTSD or lifetime Depression.

v2 physical health increased the overall explanatory power of the model to over 50%. The regression results suggested that older respondents and Latinos had deteriorating physical health compared to Whites, whereas those with higher incomes and a college degree had improving physical health. Exposure to WTCD events was no longer statistically significant, but having had a panic attack remained significant. Thus, individuals who had a strong emotional reaction to the WTCD or another event in the year after the WTCD continued to have declining physical health at W2. It was noteworthy that social support was not statistically significant in either Models 2 or 3.

The multiple regression models for the SF-12-v2 mental health were somewhat different from physical health. For the demographics-only equation (Model 1), all of the variables were statistically significant, except for education and respondents classified as Other race/no race provided. Demographic characteristics explained much less variation in mental health compared to physical health, with this model having an R^2 of .07. Including the stress risk and social psychological resource variables in the equation (Model 2) increased the explained variance to 30%. For this model, African Americans and individuals with higher incomes had better mental health relative to White and lower income respondents. Individuals with children in the home and women had lower mental health. Neither exposure to more WTCD events nor meeting criteria for a panic attack were related to this outcome. In contrast to the physical health analyses, meeting CAGE screening criteria for alcohol dependence in the two years post-disaster was associated with poorer mental health. Experiencing a negative life event and/or a traumatic event in the past year also had an adverse impact on psychological well-being. Finally, both of the social psychological resource variables were related to better mental health.

Introducing W1 SF-12-v2 mental health (Model 3) increased the explained variance but not nearly as much as seen in the model estimated for physical health. Controlling for all of the other variables in the equation, respondents with children in the home had lower mental health compared to those without children in the home and African Americans still had significantly better mental health relative to Whites. CAGE defined screening for alcohol dependence retained its statistical significance. Finally, experiencing two or more negative life events or a traumatic event predicted poorer mental health, but having high self-esteem predicted better mental health.

In additional analyses, we examined interaction models to test whether exposure to the WTCD increased the vulnerability of respondents to subsequent stressors and several models to explore the possibility that W1 physical and mental health mediates the relationship between WTCD exposure and W2 physical and mental health. None of the models with interaction terms reached statistical significance for the physical health or the mental health outcome measures. An additional set of analyses was conducted explicitly to examine the hypothesis that women exposed to the WTCD events were more vulnerable to subsequent stressful events. These models consisted of interaction terms for gender and all of the stress risk and resource variables (results not shown). Again, none of these models reached statistical significance.

Models 1 and 2 in Table 3 completed only part of the four-step process for assessing possible mediation. We performed the remaining steps (analyses available upon request): testing the association between WTCD exposure and the W1 SF12-physical and mental health components. As noted earlier in our discussion of the Pearson correlation results, level of exposure to the attacks was not related to W1 SF12-physical health, but was related to the W1 SF12-mental health component. We found the same pattern for various multivariate OLS regression equations. Thus, W1 physical health did not mediate the relationship between exposure and W2 physical health, since exposure was not related to W1 physical health. W1 SF12-mental health did not mediate the association between disaster exposure and W2 SF12-mental health, since exposure was not significant before W1 SF12-mental health was included

in the equation (Model 1). Mediation may occur between WTCD exposure and W2 well-being, but based on these findings, W1 well-being was not the mediator.

Discussion

One goal of this study was to assess the impact of exposure to the WTCD on individual well-being 2 years after the terrorist attacks. Using longitudinal data, and in contrast to our earlier cross-sectional results (Adams & Boscarino, 2005), we found that exposure was associated with lower physical health 2 years after the attacks, controlling for demographic characteristics, stress risk, and social psychological resource variables. The association between exposure and physical well-being was no longer statistically significant, however, once the model included W1 physical health. Exposure was not related to W2 mental health in any of the models. That is, the WTCD did not continue to directly affect physical and psychological well-being 2 years later.

Exposure may indirectly affect W2 well-being via its association with more negative life events and traumas between W1 and W2, and an increased likelihood of meeting CAGE screening criteria for alcohol dependence. On the other hand, individuals experiencing many WTCD-related events were not more vulnerable to the adverse consequences of subsequent negative life events and psychological traumas than those who had low levels of exposure. Thus, there was little evidence supporting the stress vulnerability hypothesis, but some support that high exposure can lead to an increase in other life problems and traumas.

In terms of the three sets of factors identified by the stress process model, our findings indicate that demographic characteristics explain much more of the variation in physical health than they did for mental health outcomes. Stress risk and social psychological resource factors, in contrast, explain more variation in mental health. In addition, social support did not have a significant association with either physical or mental health, once all other variables were controlled, while self-esteem was only related to mental health. It is possible that importance of social support diminishes overtime within the context of a community disaster.

Beyond an examination of the continued effects of this community disaster, our other aim was to assess the multiple stressors experienced by residents of NYC. As expected based on stress theory, respondents who reported more negative life events and traumatic events had poorer physical and mental health, even when controlling for earlier well-being. Of particular interest in this study was the role of panic attack in lowering physical health and screening positive for alcohol dependence in lowering mental health. Individuals who had a strong physical and emotional reaction to the terrorist attacks or other trauma following the WTCD seem to experience deteriorating physical health 2 years after the disaster, even after taking into account their earlier physical health status. Screening positive for alcohol dependence was not related to physical health, but was associated with poor mental health and its continued deterioration two years post-disaster. As stress researchers note (e.g., Thoits, 1995), increased alcohol consumption may be a coping strategy used to deal with stressful events, but it is not a very effective one. Given that other disaster studies also report an increase in alcohol use post-disaster (Pfefferbaum & Doughty, 2001; Vlahov et al., 2002), researchers should target this behavior when assessing people's mental well-being and planning health service interventions. Indeed, we recently reported in this regard that brief worksite crisis interventions following the WTCD were highly effective in reducing post-disaster alcohol problems (Boscarino, Adams, & Figley, 2005), so this information is vital for both research and evaluations purposes.

One interesting question left unanswered by the current study relates to the mechanisms by which exposure to the WTCD has both direct and indirect long-term negative consequences (Bromet et al., 2002; Norris et al., 2002). Other studies show that the most consistent risk

factors for poor physical and mental well-being among adult survivors in a population experiencing a communitywide disaster were intensity of exposure, being female, having a pre-existing psychological problem, having children in the home, and loss of social and psychological resources (Brewin et al., 2000; Bromet & Dew, 1995; Norris et al., 2002; Rubonis & Bickman, 1991). Rarely, however, have researchers closely examined how the social circumstances of survivors change due to the disaster and how these changes may mediate the effects of exposure on later well-being. Future research should also more carefully examine the type of losses suffered by disaster survivors and the disruption of valued roles and social relationships to more fully examine the conditions, which can make community traumas difficult for some survivors.

One possible reason for the WTCD's lack of direct impact on the well-being on NYC residents 2 years post-disaster has to do with the larger social context. As Norris et al. (2002) note, survivors of disasters in developing countries are more likely to experience long-lasting physical and psychological problems, because of the shortage of resources, compared to survivors in industrialized ones. Resource rich countries like the United States may have an advantage over developing countries since it has preparedness messages, building codes, rapid response plans, a developed medical infrastructure, and other resources, which can mitigate the worst consequences of a community disaster. The 1984 Bhopal cyanide gas accident in India (Murthy, 1990) or the 1988 Armenian earthquake (Giel, 1998) are two examples of traumas where local resources were inadequate to rapidly and effectively deal with these tragedies. Loss of life, social disruptions, and lack of basic necessities may be very severe and long lasting in these circumstances. Individuals in less industrialized countries, therefore, may face a very different social and economic context in the aftermath of a community trauma, than those in more advanced ones. It is interesting, then, that most of the research on disasters concentrates on those occurring in Western, industrialized nations, missing some of the world's worst disasters (Adams et al., 2002; Norris et al., 2002). Clearly, more research needs to be conducted on these community disasters in the future.

As with any study, our results need to be viewed in light of its limitations and strengths. First, our cooperation and responses rate are low and may introduce bias in our analyses. Although sampling weights correct for possible demographic biases due to our sampling design, refusal rate, and sample attrition, it is difficult to determine how response rates affect parameter estimates. We may underestimate the influence of exposure to a community disaster on well-being by having those with the worst mental health systematically refusing to participate. Alternatively, high socioeconomic status individuals may refuse at higher rates leading to a possible overestimate of the disaster's effects. Some methodologists contend that problems caused by attrition in longitudinal studies may be exaggerated (MaCurdy, Mroz, & Gritz, 1998; Sobolewski & Amato, 2005). Nevertheless, our conclusions remain tentative until verified by studies in other disaster contexts.

We are also limited in what we can say about the change in well-being overtime. As noted earlier, three or more waves of data are necessary in order to specify the shape of change. With two waves of data, we are forced to assume a linear change. We plan future waves of data collection to address this limitation. Third, we omitted individuals without a telephone and those who did not speak either English or Spanish. Given that the W1 sample matched the 2000 Census for NYC, elimination of households without a telephone or individuals who did not speak English or Spanish did not appear to introduce obvious demographic bias. There was a modest change in the W2 sample characteristics for gender, age, and race/ethnicity. Weighting the W2 data to conform to the W1 proportions for gender and race eliminated these differences compared to Census figures. Thus, the results do not appear to be influenced by demographic biases related to the original sampling frame or participant retention for W2. Nevertheless, caution should be exercised when generalizing our findings.

We are also limited in generalizing to other ethnic/language groups in NYC. Very little research focuses on how the terrorist attacks affected the physical or mental health of immigrant communities or the wide variety of ethnic groups living in NYC. Future researchers should act to fill this gap. It is possible that community-wide disasters have adverse consequences for individuals within such groups, since they tend to have fewer economic resources to buffer them from the WTCD. On the other hand, the terrorist attacks may not have as deleterious effect, since most are highly integrated into their local communities. In one of the few studies on Asian immigrants working near the WTC at the time of the terrorist attacks, however, Thiel de Bocanegra and Brickman (2004) report that about 23% of their Chinese immigrant sample scored between moderately and severely depressed and 21% met study criteria for PTSD.

The strengths of this study were that it incorporated demographic characteristics, stress risk, and social psychological resource measures in an analysis and examined their unique effects on physical and mental well-being using longitudinal data. These data allow us to time order the independent and dependent variables and go beyond a correlational analysis of disaster exposure and well-being. Additional strengths of the study come from the fact that we began with a large random sample representative of NYC, assessed physical and mental well-being using standardized and validated scales, and focused on a specific event that met the criteria for communitywide disaster.

Community disasters are complex events that can dramatically alter the post-disaster social and physical environments. Studies showing the declining prevalence of PTSD and depression since the WTCD (Galea et al., 2003) suggest that despite its seeming severity, residents were able to adopt to this situation and this supports McFarlane's (1988, 1989) contention that community disasters may have only short-term effects on psychological health. On the other hand, the possible indirect associations between disaster exposure and well-being suggests that following survivors for a longer period of time may be warranted to resolve the multiple ways in which this event affected the lives of survivors.

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Table 1

Demographic characteristics of wave 1 (W1) sample compared to 2000 US census and wave 1 sample compared to wave 2 (W2) sample[a]

Characteristic	% from US census	Weighted % from W1 sample (*n*)	Census vs. W1 χ^2 (*p*-value)	Weighted % from W2 sample (*n*)	W1 vs. W2 χ^2 (*p*-value)
Age					
18–24	13.2	15.2 (245)	1.90 (0.86)	12.7 (140)	0.73 (0.98)
25–34	22.5	24.0 (537)		21.3 (333)	
35–44	20.8	22.2 (567)		22.1 (403)	
45–54	16.7	18.7 (454)		20.3 (346)	
55–64	11.3	10.1 (272)		12.0 (227)	
65+	15.5	9.8 (247)		11.7 (208)	
Gender					
Male	46.2	46.2 (1016)	0.00 (1.00)	46.2 (693)	0.00 (1.00)
Female	53.8	53.8 (1352)		53.8 (988)	
Race					
White	38.7	39.2 (1015)	2.01 (0.74)	43.0 (782)	0.94 (0.92)
African Am.	23.0	26.3 (606)		26.0 (422)	
Asian	10.1	5.2 (99)		4.6 (62)	
Hispanic	24.7	25.7 (559)		24.1 (367)	
Other	3.6	3.5 (89)		2.4 (48)	
Borough					
Bronx	15.4	15.4 (375)	0.13 (1.00)	15.4 (253)	0.00 (1.00)
Brooklyn	29.7	29.7 (704)		29.7 (483)	
Queens	28.4	28.3 (602)		28.3 (431)	
Manhattan	21.1	21.1 (548)		21.1 (411)	
Staten Island	5.5	5.4 (139)		5.4 (103)	

[a] All percentages are weighted and all ns are unweighted.

Table 2

Weighted % and (unweighted *N*) for the longitudinal sample

Variables	Weighted % (Unweigted *N*)
Other independent variables (Wave)	
College graduate (W1)	
No	58.3 (906)
Yes	41.7 (775)
Married/Living together (W1)	
No	49.7 (972)
Yes	50.3 (709)
Children under 18 living in household (W1)	
No	57.8 (1041)
Yes	42.2 (640)
Income (W1)	
<$20,000	19.7 (375)
$20,000–$29,999	14.1 (224)
$30,000–$39,999	10.9 (185)
$40,000–$49,999	14.1 (232)
$50,000–$74,999	15.0 (259)
$75,000–$99,999	10.0 (159)
$100,000+	16.1 (247)
Negative life events past year (W2)	
None	50.2 (730)
1 Event	28.2 (487)
2 or more events	21.7 (464)
Traumatic events past year (W2)	
None	85.0 (1390)
One	9.3 (175)
Two or more	5.7 (116)
Meet Criteria for alcohol dependence past 2 years (W2)	
No	95.1 (1578)
Yes	4.9 (103)
Panic attack (W1)	
No	85.1 (1347)
Yes	14.9 (334)
	Mean (standard deviation)
Age (W1)	43.32 (15.89)
Exposure to WTCD events (W1)	2.75 (1.69)
Social support (W1)	10.91 (3.60)
Self-esteem (W1)	17.96 (2.66)
SF12-v2-Physical health (W1)	50.77 (10.41)
SF12-v2-Mental health (W1)	48.37 (9.91)
Dependent variables	Mean (standard deviation)
SF12-v2-Physical health (W2)	49.93 (10.62)
SF12-v2-Mental health (W2)	48.27 (10.22)

Table 3

Regression coefficients and standard errors for W2 SF12-v2-physical and mental health status regressed on demographic, stress, and social psychological resource variables (N = 1667)

Dependent variables	**W2 SF12-v2 Physical Health**			**W2 SF12-v2 Mental Health**		
Independent variables	**Model 1 b (s.e.)**	**Model 2 b (s.e.)**	**Model 3 b (s.e.)**	**Model 1 b (s.e.)**	**Model 2 b (s.e.)**	**Model 3 b (s.e.)**
Demographics						
Age	−.24 (.02)***	−.25 (.02)***	−.12 (.02)***	.04 (.02)*	.03 (.02)	.03 (.02)
College graduate	2.67 (.61)***	2.70 (.60)***	1.39 (.51)**	−.77 (.66)	−.78 (.59)	−.19 (.56)
Children < 18	−.46 (.64)	−.24 (.63)	.17 (.51)	−1.68 (.68)*	−1.30 (.59)*	−1.37 (56)*
Female	−.32 (.55)	−.14 (.55)	.04 (.46)	−1.70 (.59)**	−1.73 (.53)**	−.77 (.49)
Married	.31 (.62)	.18 (.59)	−.38 (.51)	1.43 (.66)*	.81 (.59)	.79 (.54)
African American	−2.22 (.76)**	−2.33 (.76)**	−1.08 (.61)	2.82 (.77)***	2.58 (.69)***	1.92 (.65)**
Latino	−2.94 (.79)***	−2.67 (.79)***	−1.61 (.65)*	−1.83 (.90)*	−1.27 (.80)	−.92 (.74)
Other/no race	−2.14 (.92)*	−1.72 (.92)	.59 (.99)	.37 (1.20)	1.50 (1.02)	.69 (1.00)
Income	1.08 (.16)***	1.04 (.16)***	.41 (.13)**	.66 (.17)***	.34 (.17)*	.26 (.15)
Stress risk						
Exposure WTCD		−.44 (.16)**	−.18 (.13)		−.32 (.16)	−.12 (.16)
1 negative life event		−1.71 (.63)**	−1.46 (.54)*		−1.55 (.62)*	−.88 (.58)
2+ negative life event		−2.49 (.79)**	−1.52 (.65)*		−6.14 (.76)***	−4.82 (.74)***
1 traumatic event		−.70 (.96)	.14 (.75)		−2.75 (.93)**	−2.57 (.91)**
2+ traumatic events		−2.25 (1.25)	−2.70 (.93)**		−2.67 (1.24)*	−1.35 (1.08)
panic attack		−1.74 (.78)*	−1.59 (.67)*		−.45 (.75)	.58 (.72)
Alcohol dependence		.54 (1.19)	−.25 (1.12)		−4.50 (1.27)***	−3.21 (1.24)**
Social psych resources						
Social support		.01 (.08)	−.02 (.07)		.20 (.08)*	.08 (.07)
Self-esteem		.26 (.12)*	.05 (.10)		1.12 (.11)***	.51 (.12)***
W1 SF12-v2			.60 (.03)***			.40 (.03)***
Constant	56.80	55.05	24.48	44.78	27.67	19.42
R^2	.24	.28	.54	.07	.30	.40

* $p < .05$,

** $p < .01$,

*** $p < .001$, two-tailed t-test.