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Worker Productivity and Outpatient Service Use After the September 11th Attacks: Results From the New York City Terrorism Outcome Study

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Abstract

Background—Research has shown that the terrorist attacks in New York City (NYC) on September 11, 2001 had an impact on the psychological status of area residents. Since a major goal of many terrorist attacks is to also adversely affect local socioeconomic activities, the long-term impact of exposure to terrorist attacks on productivity and outpatient service utilization among workers in NYC is assessed.

Methods—The impact of the World Trade Center disaster (WTCD) among 1,167 workers in NYC is examined using a prospective cohort design. The study included measures of WTCD exposures, stressful life events, other traumatic events, post-traumatic stress disorder (PTSD), and depression, assessed at 1 year and 2 years post-disaster.

Results—Bivariate analyses suggest that exposure to WTCD events is associated with high productivity loss at baseline, but not consistently at follow-up. Both PTSD and depression are associated with lower quality workdays at baseline and follow-up, but depression is more consistently associated with high work loss and medical service use. In multivariate analyses, WTCD exposure is associated with productivity loss at baseline, but less consistently at follow-up. At baseline, depression and history of traumatic events are associated with lower quality workdays and negative life events with greater workdays lost. Multivariate analyses at follow-up indicated that experiencing negative life events is associated with higher workdays lost and lower quality workdays and that PTSD is associated with lower quality workdays. Similar regression models suggested that increased outpatient service use is associated with depression and lifetime traumatic events at baseline and with negative life events at follow-up.

Conclusion—This study suggests that while the WTCD had an impact on worker productivity within the first year after the attack, this did not generally persist, especially after controlling for baseline status. Having PTSD or experiencing stressful life events at follow-up, however, is associated with lower quality workdays, even after controlling for baseline status.

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Keywords

productivity; employee health; terrorism; post-traumatic stress disorder; depression; occupational medicine; healthcare utilization

INTRODUCTION

It has been noted that a goal of terrorism is to create sufficient socioeconomic disruption to achieve political objectives otherwise unattainable [Jones and Fong, 1994]. The terrorist attacks in New York City (NYC) on September 11, 2001, killed nearly 3,000 persons, caused extensive public infrastructure damage, and had an adverse impact on the regional economy [Centers for Disease Control and Prevention, 2002a; Nandi et al., 2004]. These attacks not only increased public fears of terrorism threats [Boscarino et al., 2003a], but also had an adverse psychological impact on area residents [Boscarino et al., 2004a, 2006b; Adams et al., 2006]. Research in the post-disaster period indicates that 11% of NYC adults, approximately 700,000 persons, suffered panic attacks during this event [Boscarino et al., 2004a]. Other studies conducted nationally, and within the New York metropolitan area following the attacks, also found psychological distress widespread [Schuster et al., 2001; Galea et al., 2002; Schlenger et al., 2002]. Adding to this level of public distress during this period were the anthrax attacks that occurred in New Jersey and New York—the first publicized bioterrorism attack in US history [Greene et al., 2002]—and the onset of war in the Middle East [Boscarino et al., 2003b].

Given this stressful environment, it is reasonable to expect a long-term negative impact on worker productivity [Boscarino et al., 2003a,b]. One study conducted by the Centers for Disease Control and Prevention (CDC) shortly after the attacks, among employees who worked near the World Trade Center disaster (WTCD) site, found that both the physical and psychological health status of workers had been adversely affected [Centers for Disease Control and Prevention, 2002b]. Another study of area employees in companies that had behavioral health coverage found significant increases in anti-anxiety medication use after the attacks [McCarter and Goldman, 2002]. In addition to the terrorist attacks and ongoing threats that occurred over the past several years in NYC, it has been noted that the workplace is also a risk environment for worksite shooting, employee violence, and unintended injuries [Schouten et al., 2004]. Despite these hazards, preparedness activities in the US generally have ignored the workplace and have focused on the technological and biomedical aspects of these events [Keim and Kaufmann, 1999; Khan et al., 2000; Bravata et al., 2002], rather than on the psychosocial consequences of these exposures among workers [Boscarino et al., 2003a,b, 2005]. To our knowledge, this is the only study that provides data related to the impact of the NYC terrorist attacks and ongoing threats on worker productivity and outpatient service use, areas of potential interest for both government and industry. In this study, both the short-term (1 year after) and long-term impacts (2 years after) of these exposures are assessed. If terrorist attacks in urban civilian areas become more commonplace [Boscarino et al., 2003a,b], then understanding the impact of these events and developing interventions for working populations will be of strategic importance [Mitchell et al., 2004].

DATA AND METHODS

Survey Methods

The data for the present study come from a prospective cohort study of English- or Spanish-speaking adult residents who were living in NYC on the day of the WTCD and exposed to ongoing terrorist threats over a 2-year period. Using random-digit dialing, we conducted a baseline telephone survey 1 year after the attacks. One year later, we attempted follow-up interviews with all baseline participants (i.e., 2 years after the WTCD). Questionnaires were

translated into Spanish and then back translated by bilingual Americans to ensure the linguistic and cultural appropriateness. For most of the scales discussed below, the test developer's Spanish version of the measure is used. Baseline interviews occurred between October and December 2002. The follow-up interviews occurred between October 2003 and February 2004.

The procedures were the same for both surveys. Trained interviewers using a computer-assisted telephone interviewing system conducted the interviews and were supervised 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 [Boscarino et al., 2004a]. The mean duration of the interviews was about 45 minutes for baseline and 35 minutes for follow-up. The Institutional Review Board of the New York Academy of Medicine reviewed and approved the study protocols.

As part of the study design, residents who reported receiving mental health treatment in the year prior to the baseline survey, identified by means of screener questions at the beginning of the survey, are over sampled. The population was also stratified by the five NYC boroughs and sampled proportionately.

Sampling weights were developed for each wave 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 [Groves et al., 2004]. As discussed below, demographic weights also were used in the follow-up wave, in order to adjust for slight differences in response rates by different demographic groups, a common practice in panel surveys [Kessler et al., 1995]. With these survey adjustments, our study is considered representative of adults who were living in NYC on the day of the WTCD [Groves et al., 2004].

This study focuses on the workplace. Respondents who were not working, including those who were retired, students, homemakers, on sick leave, on maternity leave, those who were disabled, as well as those who were working at year 1, but not year 2, were eliminated from our study. In addition, we eliminated respondents who were 65 or older, since we wanted to concentrate on individuals in their primary working years. These selection criteria resulted in eliminating 514 respondents (475 not working and 39 who were 65+ years old) from the 1,681 adults in our panel data, resulting in 1,167 persons for our analyses.

Study Outcome Variables

The outcomes of interest in our present study were adopted from standard measures of worker productivity used in previous research. Based on previous productivity studies related to workdays lost and lower quality workdays reported [Kessler and Frank, 1997; Kessler, 2000; Kessler et al., 2001], at baseline and follow-up, respondents were asked the following questions: "Now think about the last 4 weeks you worked for pay or profit; during these 4 weeks, on how many days did you: (i) miss an entire day of work because of health problems; (ii) miss part of a work day because of health problems; or (iii) perform lower quality work than you normally would have?" These survey questions had been used and validated in previous occupational health studies [Kessler and Frank, 1997; Kessler, 2000; Kessler et al., 2001]. In addition to these measures, we also asked respondents to report the number of visits they had to a medical doctor's office in the past 12 months for medical care or for medical tests. This healthcare utilization measure has been used in population health studies designed to assess services utilization, including the ongoing *National Health Interview Survey*, conducted by the National Center for Health Statistics [Benson and Marano, 1996]. For descriptive bivariate analyses, 3+ workdays lost, cutback, or 3+ lower quality workdays were reported as high productivity loss. For outpatient service use, we dichotomized 5 doctor visits as high service utilization. These designated cut points represented about the 90th percentile (or greater) for these survey measures, respectively (unweighted).

Study Predictor and Control Variables

Demographic characteristics—Analyses included six demographic measures used as study control variables, including: age, education, gender, marital status, race/ethnicity, and income. Age was coded in years (baseline mean = 38.6; SD = 11.8). Education was coded as an ordinal scale ranging from 1 to 5, representing less than high school through to graduate school (baseline mean = 3.3; SD = 1.2). Female gender and marital status (dichotomized as married/cohabitating vs. not) were coded as binary variables. Consistent with past research [Galea et al., 2002; Boscarino et al., 2004a; Breslau et al., 2005], race/ethnicity was classified based on self-report and coded as a categorical variable as follows: White, Black or African American, Latino/Hispanic, and Other. Income was coded as a 7-category ordinal scale, representing under \$20,000 to greater than \$100,000 (baseline mean = 4.1; SD = 2.1). Approximately, 3% of respondents had missing data for income after substituting follow-up responses, if baseline responses were missing. For these 3% of cases, we substituted the mean baseline income category for these respondents.

Post-traumatic stress disorder (PTSD)—Our PTSD scale was based on the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* [American Psychiatric Association, 1994] and specifically designed for telephone administration [Resnick et al., 1993; Kilpatrick et al., 1998]. To meet the PTSD criteria, a respondent had to be exposed to a traumatic event and experience intense feelings of fear, helplessness, or horror (Criteria A1 and A2). Second, the person had to re-experience the event in one of five ways (Criteria B), avoid stimuli associated with the event in three of seven ways (Criteria C), and had to have increased arousal in two of five ways (Criteria D). Third, the symptoms for Criteria B, C, and D had to last 1 month or longer (Criteria E). Finally, the symptoms had to have a significant impact on the individual's functional status (Criteria F). Our PTSD assessment involved three sets of experiences, including the WTCD, the most stressful traumatic event experienced “other than the WTCD,” and any other traumatic event experienced. To have PTSD, the person had to meet criteria A through F for one or more of these traumatic events. Data supporting the validity of this instrument have been presented elsewhere and suggested that this scale can successfully diagnose PTSD in the general population [Resnick et al., 1993; Kilpatrick et al., 1998; Galea et al., 2002; Boscarino et al., 2004a,c]. For the current analyses there are two measures of PTSD: PTSD in the past year (baseline) and PTSD in year 1 or year 2 (followup). This was done because, for some persons, PTSD was delayed following the WTCD, not an unusual finding in a post-disaster assessment [Adams and Boscarino, 2006]. In addition, as noted elsewhere [Adams et al., 2006], even though individuals may not have met the full PTSD criteria in year 2, many have partial or sub-syndrome PTSD and are still impaired, if they were PTSD positive at baseline [Adams and Boscarino, 2006]. Consequently, classifying PTSD as present in either time period, we believe, potentially captures this information during the follow-up period. Altogether, 6.9% (95% CI = 5.2–8.6) of workers had PTSD in year 1 or year 2 (4.2 % [95% CI = 3.0–5.5] had PTSD in year 1; 3.3 [95% CI = 2.2–4.5] had PTSD in year 2).

Depression—For a diagnosis of major depression, a version of the SCID's major depressive disorder scale from the non-patients version is used [Spitzer et al., 1987], which also has been extensively used in telephone-based, population surveys [Acierno et al., 2000; Galea et al., 2002; Kilpatrick et al., 2003; Boscarino et al., 2004a,c]. Following DSM-IV criteria [American Psychiatric Association, 1994], respondents met the criteria for depression if they had five or more depression symptoms for at least 2 weeks. In the current study, Cronbach's alpha for the 10 symptoms used in this scale was 0.87. Data related to the validity of this scale were also previously reported and suggested that this scale can successfully diagnose depression in the general population [Acierno et al., 2000; Galea et al., 2002; Kilpatrick et al., 2003; Boscarino et al., 2004a,c]. For the current analyses we had two measures of depression: depression in the

past year (baseline) and depression in year 1 or year 2 (follow-up). Again, we did this because even though the person no longer met the full depression criteria, many still had partial depression and were still impaired. Consequently, as with PTSD, classifying depression as present in either time period potentially captures this information during the follow-up period. Altogether, 16.8% (95% CI = 14.3–19.3) of workers had depression in year 1 or year 2 (11.0% [95% CI = 8.9–13.1] had depression in year 1; 10.0 [95% CI = 8.0–12.0] = had depression in year 2).

Stressor measures—In addition to PTSD and depression, our statistical models included three stressor variables that could affect outcomes. The first stressor measure was a WTCD event exposure measure, which was only assessed during the baseline survey. This consisted of 14 possible events that the respondents could have experienced during the attacks (e.g., was at the WTCD site during attack, had to be evacuated, lost job, etc.). The year 1 baseline mean for this measure was 2.8 (95% CI = 2.7–3.0). For bivariate analyses, high exposure is classified as experiencing 6 or more of these events; those with a score of 6+ events were at the 95th percentile for this exposure measure (unweighted). This exposure measure is used as a continuous variable as is common in traumatic stressor research [Adams and Boscarino, 2005]. The second stressor measure was a negative life event scale [Freedy et al., 1993], which was the sum of eight experiences that the respondent could have had in the year before the WTCD (e.g., divorce, death of spouse, problems at work, etc.). The year 1 baseline mean for this measure was 0.6 (95% CI = 0.6–0.7) and 42% had one or more stressful events at baseline. The follow-up survey contained the same negative life events scale, but covered the past 24 months, that is, from baseline through follow-up. The year 2 follow-up mean for this measure was 0.8 (95% CI = 0.8–0.9) and 50% had one or more stressful events at follow-up. The mean negative life events experienced was between year 1 and year 2 combined was 1.4 (95% CI = 1.3–1.5) and 65% had one or more of these events at baseline or follow-up. In our analyses these measures were used as continuous variables, which is consistent with life events-related research [Adams and Boscarino, 2005]. The Third stressor measure was a traumatic events scale that included 10 traumatic events (e.g., forced sexual contact, being attacked with a weapon, having a serious accident, etc.) [Freedy et al., 1993]. For both the baseline and follow-up, and consistent with the other mental health and stressor scales used in our analyses, the trauma scale measured lifetime trauma from the time of survey. The mean of this trauma measure at year 1 baseline was 1.7 (95% CI = 1.6–1.9) and at year 2 follow-up it was 0.2 (0.2–0.3). Combined for follow-up at year 2 the mean was 1.9 (95% CI = 1.8–2.1). All three stressor measures were used and validated in previous WTCD studies and discussed in detail elsewhere [Galea et al., 2002; Boscarino et al., 2004a,c; Adams and Boscarino, 2005; Boscarino et al., 2005; Adams et al., 2006; Boscarino et al., 2006b].

History of chronic diseases—To control for physical health status in our study, we ascertained whether the respondent *ever* had been told by a doctor that he/she had any chronic diseases, such as high blood pressure, asthma, heart disease, cancer, etc. This survey measure is commonly used in population health studies designed to assess disease prevalence, including the *National Health Interview Survey* conducted by the National Center for Health Statistics [Benson and Marano, 1996]. Consistent with other studies [Kessler et al., 2001], a count of these chronic conditions (mean = 0.9 [95% CI = 0.8–0.9]) was developed and used this as a continuous measure to control for level of physical health impairment.

Other Study Variables Assessed

For descriptive and analytical purposes, our analyses also included measures of mental health visits, social support, and self-esteem, which were each measured in the baseline and follow-up surveys, respectively.

Mental health service utilization—Respondents were asked about the use of mental health services, using the National Comorbidity Survey (NCS) items [Kessler et al., 1997, 1999]. Specifically, participants were asked about receiving counseling from a helping professional (e.g., psychiatrist, counselor, physician, self-help group, etc.) for “problems with emotions or nerves or use of alcohol or drugs” after the attacks. We asked how many visits they had to each of these professionals during the past 12 months in both the baseline and in the follow-up surveys, respectively. This measure has been used and validated in previous national surveys [Kessler et al., 1997, 1999]. For the current study, a measure of the total count of mental health visits across all providers for each survey period (baseline mean = 4.9 [95% CI = 3.8–5.9]) were developed. A more detailed description of this mental health use measure has been presented elsewhere [Boscarino et al., 2004a].

Social support—Social support was based on the sum of four questions about emotional, informational, and instrumental support currently available to the respondent measured on a 4-point scale (e.g., someone available to help you if you were confined to bed; “not at all” to “all the time”) (baseline mean = 11.1 [95% CI = 10.8–11.4]) [Sherbourne and Stewart, 1991]. This measure was used and validated in previous studies and discussed in detail elsewhere [Galea et al., 2002; Boscarino et al., 2004a; Adams and Boscarino, 2005; Adams et al., 2006].

Self-esteem—Self-esteem was measured by a brief version of the Rosenberg self-esteem scale [Rosenberg, 1979]. This measure is the sum of five items measured on a 4-point scale (e.g., on the whole, I am satisfied with myself; never to always) (baseline mean = 18.2 [95% CI = 18.0–18.3]). This measure was also used and validated in previous studies and also discussed in detail elsewhere [Boscarino et al., 2004a; Adams and Boscarino, 2005; Adams et al., 2006].

Statistical Analysis

The analytic strategy consisted of several steps. Univariate, descriptive statistics for the population demographics, health status, and productivity measures discussed are presented. The associations between productivity and health status measures at baseline and follow-up, using paired statistical tests (McNemar test for binary and paired *t*-test for continuous outcomes) are assessed. Descriptive bivariate results also are presented to explore associations between our outcome measures and our mental health and WTCD exposure measures. As noted, for these bivariate analyses, productivity, outpatient service use, and WTCD event measures are dichotomized at about the 90th percentile for descriptive purposes. Next, a series of multivariate ordinary least-squares (OLS) regression equations are estimated. For baseline productivity, we predict lost productivity at baseline from baseline PTSD, depression, WTCD exposure, negative life events, and lifetime trauma measures, controlling for age, education, gender, marital status, race/ethnicity, income, and the number of chronic medical conditions reported. For follow-up, the same regressions are conducted, except that for PTSD, depression, negative life events, and lifetime trauma variables we combined these predictors across the baseline and follow-up surveys (as noted, WTCD exposure was only assessed at baseline). These combined mental health and exposure measures at follow-up are used to assess the overall impact of these factors on worker outcomes. These regression analyses, thus, assessed the association between stressor exposures, PTSD, depression and productivity outcomes, controlling other factors that could have affected the results. Since healthcare service utilization was also of interest, OLS regressions are estimated for these outcomes as well, using the same models discussed for productivity. Finally, due to the skewed distributions for productivity and healthcare utilization measures, these variables are log transformed and used in the multivariate analyses. For all analyses, the survey estimation (svy) command set in Stata, version 9.1 [Stata Corporation, 2005] is used to generate point estimates, cross-tabulations,

and estimate 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, to correct the data for selection bias and for study over-sampling.

RESULTS

Overall 2,368 individuals completed the baseline survey and 1,681 completed the follow-up survey. Approximately 7% of the interviews were conducted in Spanish at baseline and 5% at follow-up. Using industry standards [American Association for Public Opinion Research, 2000], as reported elsewhere, the baseline cooperative rate was approx. 63% and the re-interview rate for follow-up was 71% [Adams et al., 2006]. The demographic characteristics of our sample are shown in Table I. As can be seen, the study population represents a cross-section of the NYC workers, with 51% female, 46% college graduates, 26% African Americans, and 26% Hispanics. The mean population age was 39 years old. The point estimates related to health status and productivity are also shown in Table I. As can be seen, 4% and 11% of workers met the criteria for PTSD and depression 1 year post-disaster, respectively. Among workers, the average number of outpatient visits to medical doctors in the past year was three and the average number of visits to mental health professionals or self-help groups was five visits. Our health status results appeared to be similar at follow-up as well. In terms of productivity measures, both in the baseline and follow-up surveys the average for days missed and part-days missed in the past month was about half a day. In terms of poor-quality workdays reported in the past month, during both periods the average poor-quality days reported was approximately 1 day (Table I). In terms of changes from baseline to follow-up, the only significant difference found was for doctor visits, whereby there was a slight increase in the follow-up period ($P < 0.05$).

Bivariate associations between productivity measures and outpatient medical visits are shown in Table II. As can be seen, at baseline, missing 3 or more days, missing 3 or more part days, or experiencing 3 or more lower quality days were all associated with high exposure to the WTCD ($P < 0.01$). However, having PTSD in the past year was only associated with experiencing 3 or more lower quality workdays ($P < 0.001$). Depression in the past year was also associated with part workdays missed ($P < 0.01$) and lower quality workdays reported at baseline ($P < 0.001$). Experiencing five or more doctor visits in the past year was associated with PTSD ($P < 0.01$) and depression ($P < 0.001$) at baseline. During the study follow-up (2 years post-disaster), high WTCD exposure was only associated with lower quality workdays ($P < 0.01$). PTSD at follow-up was associated with both part workdays missed ($P < 0.01$) and lower quality workdays reported ($P < 0.001$). Depression at follow-up was associated with all three lower productivity indicators ($P < 0.01$). At follow-up, higher outpatient medical visits were also associated with depression ($P < 0.05$) (Table II).

The multivariable regression results for our baseline productivity measures (Table III, top panel) confirmed that stressor exposures generally had an impact on missing workdays and reports of lower quality workdays, even after controlling for demographic factors, mental health status, and existing medical conditions (M1–M4). For baseline, only in the final model for lower quality workdays (M4), was current depression a significant predictive factor ($P < 0.001$), concurrent with WTCD exposure ($P < 0.05$), and lifetime exposure to psychological trauma ($P < 0.001$). Having PTSD or depression was not related to missing an entire day of work or missing part a workday at baseline in the multivariable model. However, PTSD was significant for the lower quality workday model ($P < 0.05$), before depression was added (M2).

During the follow-up period, the findings were somewhat different (Table III, middle panel). In terms of full or part workdays missed, unlike baseline, WTCD exposure appeared to have little impact in the models assessed. In addition, only exposure to negative life events was

significant for full workdays missed ($P < 0.05$). However, for lower quality workdays, PTSD was significant in the model without depression ($P < 0.01$) (M2) and remained significant in the full model that included depression (M4) ($P < 0.01$). Interestingly, in the final quality workday model (M4), WTCD was significant during follow-up, but lifetime trauma exposure was not compared to baseline. However, exposure to negative life events was now significant for lower quality days in all the models (M1–M4) ($P < 0.01$). As a final assessment, we conducted additional analyses, whereby we included the respective baseline measure for each of our three follow-up productivity measures assessed (Table III, bottom panel). This is generally considered a conservative approach, since this adjusts for the baseline status of the follow-up measure (7). These “lagged” models generally produced similar results, especially for lower quality workdays. For example, in the final workday quality model (M4), we found that PTSD ($P < 0.01$) and negative life events ($P < 0.01$) remained significant for lower quality workdays, while WTCD was now marginally significant in the final multivariable model ($P < 0.10$).

Because employers are concerned about employee health care costs [Goetzel et al., 1998], we used the same multivariable models to examine outpatient service utilization (Table IV). After controlling for demographic factors, mental health status, and chronic medical conditions (M1–M4) (Table IV, top panel), it was found that in the baseline period exposure to lifetime traumatic events is associated with greater physician office visits ($P < 0.01$) (M1). In the final baseline model (M4), this was still significant ($P < 0.05$) together with having had depression in the past year ($P < 0.01$). During the follow-up period (Table IV, middle panel), exposure to negative life events was now significant (M1) and remained significant even in the final model ($P < 0.01$) (M4). In the final model for the follow-up period (M4), interestingly, WTCD exposure was also marginally significant ($P < 0.10$). As a final assessment, the baseline measure for our follow-up outcome of interest is included (Table IV, bottom panel). As can be seen, these results were similar to follow-up results without baseline adjustments. Controlling for baseline services utilization, the most significant variable in the model was exposure to negative life events ($P < 0.01$), followed by WTCD event exposures ($P < 0.10$).

DISCUSSION

As noted, the WTCD attacks not only increased public fears and concerns about future attacks [Boscarino et al., 2003a,b], but also affected the psychological status of area residents [Galea et al., 2002, 2003; Boscarino et al., 2004a, 2006a,b]. In addition, as mentioned, adding to the level of distress among area residents was knowledge of the anthrax attacks that occurred in New Jersey and NYC after the September attacks [Greene et al., 2002] and the onset of war in the Middle East [Boscarino et al., 2003b]. Thus, it is reasonable to expect that these experiences would have an adverse impact on workforce productivity [McCarter and Goldman, 2002; Centers for Disease Control and Prevention, 2002b; Boscarino et al., 2003a, 2006a,b]. As also noted, in addition to terrorist threats, the workplace in general is a higher risk environment for such things as interpersonal violence and industrial accidents. Despite these risks, little has been done related to workforce surveillance and preparedness [Schouten et al., 2004]. In addition, other studies have consistently documented the impact of mental health disorders on work loss, lower worker productivity, and worker disability [Kessler and Frank, 1997; Kessler, 2000; Stewart et al., 2003].

As seen, in bivariate analyses, this study suggests a strong association between exposure to the WTCD and lower worker productivity, especially in the first year after the attack. The occurrence of PTSD and depression were also associated with these outcomes. In the second year after the attack, bivariate analyses suggested that these associations were also present, but not as consistent. Increased office visits were associated with PTSD and depression at baseline and with depression at follow-up. Furthermore, multivariate analyses suggested that at baseline

productivity losses were associated with exposure to major stressors (including WTCD events, stressful life events, and history of traumatic stress exposures), and depression. During the follow-up, these associations mostly held for lower quality work only, even when controlling for baseline status. Interestingly, for the year 2 follow-up, it was PTSD that was associated with lower work quality, not depression. In terms of outpatient medical visits, depression and history of lifetime trauma were associated with office visits during baseline, but during the follow-up, this was associated with negative life events and, to a lesser degree, WTCD exposures.

In summary, while exposure to the WTCD events appear to have had an impact on worker productivity (as measured by work loss and lower work quality) this was mostly confined to the first year post-disaster. However, there were other factors that had a negative impact on productivity, such as mental health status, and history of exposures to other stressful events. These findings were similar for post-disaster medical visits as well. Given the high-stress environment post-disaster, the lack of a consistent environmental impact among workers is noteworthy and may suggest that psychological resilience was higher than expected [Bonanno, 2004; Yehuda, 2004; Agaibi and Wilson, 2005]. To explore this further, within the context of the current study, measures of self-esteem and social support were entered into our regression models, measures that have been described elsewhere [Adams et al., 2006]. While these “protective” measures had a limited impact on the outcomes discussed, they generally tended to offset lower productivity. Clearly additional research is needed to more fully assess this phenomenon. Given previous reports of increased post-disaster vulnerability [Adams et al., 2006], we also assessed whether there was an interaction effect between WTCD exposure and stressful life events, but no association was found. Nevertheless, in terms of “quality” workdays, both PTSD and depression appeared to have both a short- and long-term negative impact, consistent with other non-disaster mental health research results reported by others [Kessler and Frank, 1997; Kessler, 2000].

It should be noted that there are both limitations and strengths associated with this study. First, by omitting individuals without telephones and those who did not speak either English or Spanish, vulnerable individuals may have been missed. Ideally the baseline response rate could have been higher. As the final sample matched the 2000 Census for NYC, [Adams et al., 2006], these exclusions did not appear to have introduced systematic bias. Nevertheless, generalizations about the associations found beyond English-and Spanish-speaking workers are limited and our study results may include selection bias. In addition, even though standardized and validated instruments are used, all measures discussed were based on self-report. Furthermore, although there has been progress in assessing mental health status using standardized instruments [Adams et al., 2002; Kessler et al., 1994, 2003], there continue to be discrepancies. Finally, these conclusions are limited by the retrospective nature of the pre-disaster data, in that there was no data collected before the disaster. The disaster experience itself may have altered recall related to pre-disaster mental health and/or post-disaster productivity. The data also do not allow us to model the changes in worker productivity over a longer period of time. This limitation, though, is common in much disaster-related research [Adams et al., 2002; Galea et al., 2002]. A more complex issue that has emerged in recent years relates to the possibility that some persons exposed to traumatic events actually grow personally from these experiences, as these can be life-defining events [Calhoun and Tedeschi, 2006]. This phenomenon, often labeled “post-traumatic growth” theory, suggests that both measurement and follow-up will require more sensitive assessment and longer follow-up than was available in our current study [Calhoun and Tedeschi, 2006].

Despite these limitations, this study suggests that while there was a post-disaster impact on worker productivity and medical service use, this impact was fairly limited and mostly confined to the first year. Generally, experiencing negative life events had a more consistent and longer

term impact than WTC event exposures. Interestingly, PTSD appeared to have a long-term impact on reported work quality 2 years after the WTC, suggesting the possibility of a delayed psychological response, a phenomenon that has been reported elsewhere [Adams and Boscarino, 2006]. Also of interest, at least within the context of the current study, depression was only associated with adverse worker outcomes in the multivariable model within the first year post-disaster, but not the second year—a finding suggesting further investigation. It is important to note that this study controlled for existing medical conditions, as well as socioeconomic status, race, gender, age, and other key variables, so these findings are less likely confounded by such factors. In general, this study suggests that New York workers were more resilient than originally thought to the stressors of September 11th, but at the same time, they may have been vulnerable to the stresses and strains of daily life, as other worker studies have suggested in the past [Goetzel et al., 1998]. In addition, the events of September 11th seem to have had more of a long-term impact on the quality of work performed, rather than on absenteeism, per se.

Nevertheless, given these findings, public health interventions might be considered, including low-key public service announcements, as well as workplace preparedness campaigns [Boscarino et al., 2006a]. A recent survey found that the majority of New Yorkers were unaware of the New York Department of Health's Bioterrorism website [Boscarino et al., 2006a]. This figure could be improved and assessed over time following educational efforts. Post-event health assessments should be considered in the event of future critical incidents, something not usually undertaken because of mental health concerns, which have been proven mostly unfounded [Boscarino et al., 2004a]. Drawing on past experiences, it has been suggested that public health and communication efforts can reduce adverse population outcomes [Boscarino et al., 2006a]. It has also been noted that risk-communication efforts can have the effect of not only reducing panic, but also promoting self-protecting behaviors and preventing misinformation [Boscarino et al., 2006a]. Although additional research is needed, a recent study indicated that worksite crisis interventions in NYC after the September 11th attacks were effective in reducing post-disaster mental health problems among workers [Boscarino et al., 2005], clearly a positive public health finding within the current context.

In summary, while knowledge gaps exist, the information needed to mitigate the impact of terrorist events is available. Health departments, emergency response personnel, and others in the disaster response community, need to be aware of this knowledge. Furthermore, while there is usually a reluctance among first-responder professionals to support post-disaster research [Boscarino et al., 2004a], it is suggested that this is what is often needed for better planning and response. As seen in this study, the time-to-recovery for workers in NYC was good following the attacks. However, in the absence of such research, it is likely that such outcomes would still be a matter of speculation. As suggested, the effects of post-disaster exposures are complicated—they could be immediate, delayed, nonlinear, or manifested indirectly, such in the case of after-disaster alcohol abuse [Boscarino et al., 2006b]. In any case, longitudinal research that examines multiple risk factors is normally required to fully assess the impact of such events.

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TABLE I
Health Status and Worker Productivity Following Terrorist Attacks in New York City

Sample characteristics	Unweighted N	Weighted % or mean [*]	95% CI
Demographics			
Mean age	1,167	38.60	37.70–39.48
% Female gender	651	50.97	47.30–54.62
% College graduate	607	46.16	42.62–49.73
% White	519	40.61	37.21–44.10
% African American	298	25.72	22.72–28.97
% Hispanic	259	25.63	22.46–29.09
% Other race/ethnicity	91	8.04	6.31–10.18
Baseline: health status			
% PTSD past year	79	4.24	3.01–5.48
% Depression past year	192	11.02	8.94–13.11
Mean number of doctor visits past year	1,167	3.17 ^a	2.88–3.47
Mean number of mental health visits past year	1,167	4.86	3.81–5.92
Follow-up: health status			
% PTSD past year	58	3.33	2.17–4.51
% Depression past year	166	10.01	8.04–11.98
Mean number of doctor visits past year	1,167	3.73 ^a	3.41–4.04
Mean number of mental health visits past year	1,167	4.15	3.21–5.09
Baseline: productivity			
Mean missed days of work past month	1,167	0.58	0.40–0.75
Mean missed part of workday past month	1,167	0.33	0.22–0.43
Mean poor-quality workdays past month	1,167	0.88	0.66–1.10
Follow-up: productivity			
Mean missed days of work past month	1,167	0.61	0.45–0.76
Mean missed part of workday past month	1,167	0.36	0.24–0.48
Mean poor-quality workdays past month	1,167	0.84	0.69–1.01

PTSD, posttraumatic stress disorder.

* All percentages, means & confidence levels are based on weighted data; N's reflect unweighted data.

^a Baseline measure is statistically different from follow-up measure, $P < .05$, paired t -test, 2-tailed.

TABLE II
Productivity and Outpatient Visits by WTCD Exposure, PTSD and Depression(N = 1,167)^a

Study outcome measures	Total sample % (N)	% High WTCD exposure ^b	Baseline % PTSD	Baseline % depressed
Baseline worker productivity loss and outpatient service use ^b				
Missed entire day 3+ times past month				
No	94.6 (1,084)	86.3 (122) **	90.8 (68)	91.6 (166)
Yes	5.5 (83)	13.7 (19)	9.2 (11)	8.4 (26)
Missed part day 3+ times past month				
No	97.2 (1,122)	92.2 (131) **	94.8 (73)	93.9 (174) **
Yes	2.8 (45)	7.8 (10)	5.2 (6)	6.1 (18)
Lower quality workday 3+ times past month				
No	91.9 (1,039)	83.2 (116) **	79.4 (56) ***	79.5 (144) ***
Yes	8.1 (128)	16.7 (25)	20.6 (23)	20.6 (48)
5+ Visits to medical doctor past year				
No	81.7 (908)	76.0 (101)	64.1 (55) **	68.7 (122) ***
Yes	18.3 (259)	24.0 (40)	35.9 (24)	31.3 (70)
	Total sample % (N)	% High WTCD exposure ^b	Follow-up % PTSD	Follow-up % depressed
Follow-up worker productivity loss and outpatient service use ^b				
Missed entire day 3+ times past month				
No	94.0 (1,090)	93.9 (128)	90.8 (50)	88.3 (139) **
Yes	6.0 (77)	6.1 (13)	9.2 (8)	11.7 (27)
Missed part day 3+ times past month				
No	96.8 (1,118)	94.5 (129)	90.6 (51) **	92.8 (147) **
Yes	3.2 (49)	5.5 (12)	9.4 (7)	7.2 (19)
Lower quality workday 3+ times past month				
No	90.3 (1,018)	82.4 (113) **	63.2 (37) ***	73.8 (110) ***
Yes	9.7 (149)	17.6 (28)	36.8 (21)	26.2 (56)
5+ Visits to medical doctor past year				
No	75.8 (834)	72.7 (95)	69.9 (33)	66.6 (97) *
Yes	24.2 (333)	27.4 (46)	30.1 (25)	33.4 (69)

WTCD, World Trade Center Disaster. PTSD, posttraumatic stress disorder.

^a All percentages are based on weighted data. All N's are based on unweighted data.

^b High WTCD exposure defined at the 90th percentile (or higher) for WTCD exposure; high productivity loss defined at 3+ days per month and high outpatient utilization defined at 5+ visits per year, representing the 90th and 80th percentiles (or higher), respectively.

* $P < 0.05$, χ^2 test.

** $P < 0.01$, χ^2 test.

*** $P < 0.001$, χ^2 test.

TABLE III
Multivariate Linear Regression Coefficients and (Standard Errors) Predicting Worker Productivity, Baseline & Follow-Up (N=1,167)^a

Predictor variables ^b	Number of days missed entire day of work past 30 days (log)				Number of days missed part of workday past 30 days (log)				Number of days performed lower quality work past 30 days (log)			
	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
Baseline status												
PTSD	—	0.05 (.08)	—	0.01 (.08)	—	0.03 (.06)	—	0.01 (.06)	—	0.25 (.12)	—	0.10 (.13)
Depression	—	—	0.08 (.05)	0.07 (.05)	—	—	0.03 (.04)	0.03 (.04)	—	—	0.33 (.09)	0.30 (.09)
Exposure to WTCD	0.03 (.01)	0.03 (.01)	0.02 (.01)	0.02 (.01)	0.03 (.01)	0.03 (.01)	0.03 (.01)	0.03 (.01)	0.04 (.01)	0.03 (.01)	0.03 (.01)	0.03 (.01)
Negative life events	0.06 (.02)	0.06 (.03)	0.05 (.03)	0.05 (.03)	0.05 (.02)	0.05 (.02)	0.04 (.02)	0.04 (.02)	0.05 (.02)	0.04 (.02)	0.03 (.02)	0.03 (.02)
Traumatic events	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.00 (.01)	-0.00 (.01)	-0.00 (.01)	-0.00 (.01)	0.05 (.01)	0.05 (.01)	0.05 (.01)	0.05 (.01)
R ²	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.07	0.09	0.09
Follow-up status												
PTSD past 2 years	—	0.04 (.08)	—	0.02 (.08)	—	-0.00 (.06)	—	-0.02 (.05)	—	0.40 (.12)	—	0.37 (.12)
Depression past 2 years	—	—	0.05 (.06)	0.05 (.07)	—	—	0.04 (.05)	0.04 (.05)	—	—	0.16 (.07)	0.08 (.07)
Exposure to WTCD	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.04 (.01)	0.03 (.01)	0.03 (.01)	0.03 (.01)
Negative events past 3 years	0.04 (.01)	0.04 (.01)	0.04 (.02)	0.04 (.02)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.08 (.02)	0.06 (.02)	0.06 (.02)	0.05 (.02)
Traumatic events	0.02 (.01)	0.02 (.01)	0.02 (.01)	0.02 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.00 (.01)	-0.00 (.01)	0.00 (.01)	-0.00 (.01)
R ²	0.07	0.07	0.07	0.11	0.05	0.05	0.05	0.05	0.07	0.09	0.08	0.10
Follow-up status with baseline controlled												
PTSD past 2 years	—	0.04 (.08)	—	0.02 (.08)	—	-0.00 (.05)	—	-0.02 (.05)	—	0.33 (.11)	—	0.31 (.10)
Depression past 2 years	—	—	0.05 (.06)	0.05 (.07)	—	—	0.03 (.05)	0.04 (.05)	—	—	0.11 (.07)	0.04 (.07)
Exposure to WTCD	0.00 (.01)	0.00 (.01)	0.00 (.01)	0.00 (.01)	0.01 (.01)	0.01 (.01)	0.00 (.01)	0.00 (.01)	0.03 (.01)	0.02 (.01)	0.03 (.01)	0.02 (.01)
Negative events past 3 years	0.03 (.01)	0.03 (.01)	0.03 (.02)	0.03 (.02)	0.00 (.01)	0.00 (.01)	-0.00 (.01)	-0.00 (.01)	0.06 (.01)	0.05 (.01)	0.05 (.02)	0.05 (.02)
Traumatic events	0.02 (.01)	0.02 (.01)	0.02 (.01)	0.02 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)	-0.01 (.01)	-0.02 (.01)	-0.01 (.01)	-0.02 (.01)

Follow-up status with baseline controlled								
	M1	M2	M3	M4	M1	M2	M3	M4
Baseline measure ^c	0.19 (.06) ***	0.19 (.06) **	0.19 (.06) ***	0.19 (.06) **	0.28 (.08) ***	0.28 (.08) ***	0.28 (.08) ***	0.28 (.08) ***
R2	0.10 ***	0.10 ***	0.11 ***	0.11 ***	0.11 ***	0.11 ***	0.11 ***	0.11 ***

WTCD, World Trade Center Disaster; PTSD, posttraumatic stress disorder.

^a All calculations are based on weighted data and take into account the data collection's sampling design.

^b Other variable in the models: age, education, gender, marital status, race/ethnicity, income, and number of physical diseases/conditions.

^c Baseline measures controlled final models included: entire days of work missed at baseline; part days of work missed at baseline; and days performed lower quality work at baseline, respectively.

^d $P < .10$, two-tailed t -test.

* $P < .05$, two-tailed t -test.

** $P < .01$, two-tailed t -test.

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

TABLE IV

Multivariate Linear Regression Coefficients and (Standard Errors) Predicting Outpatient Doctor Visits, Baseline & Follow-Up (N = 1,167)^a

Predictor variables ^b	Number of medical doctor visits past year (log)			
Baseline status	M1	M2	M3	M4
PTSD	—	0.11 (.12)	—	-0.01 (.12)
Depression	—	—	0.23 (.08) **	0.24 (.09) **
Exposure to WTC	0.01 (.02)	0.00 (.02)	-0.00 (.02)	-0.00 (.02)
Negative life events	0.03 (.03)	0.03 (.03)	0.02 (.03)	0.02 (.03)
Traumatic events	0.04 (.02) **	0.04 (.02) *	0.04 (.02) **	0.04 (.02) *
R ²	0.16 ***	0.16 ***	0.17 ***	0.17 ***
Follow-up status	M1	M2	M3	M4
PTSD past 2 years	—	-0.10 (.11)	—	-0.13 (.11)
Depression past 2 years	—	—	0.05 (.07)	0.08 (.08)
Exposure to WTC	0.02 (.01)	0.03 (.01) [†]	0.02 (.01)	0.02 (.01) [†]
Negative events past 3 years	0.06 (.02) ***	0.07 (.02) ***	0.06 (.02) **	0.06 (.02) **
Traumatic events	0.01 (.01)	0.01 (.01)	0.01 (.01)	0.01 (.01)
R ²	0.16 ***	0.16 ***	0.16 ***	0.16 ***
Follow-up status	M1	M2	M3	M4
PTSD past 2 years	—	-0.12 (.10)	—	-0.14 (.11)
Depression past 2 years	—	—	0.01 (.07)	0.04 (.07)
Exposure to WTC	0.02 (.01) [†]	0.03 (.01) [†]	0.02 (.01) [†]	0.03 (.01) [†]
Negative events past 3 years	0.05 (.02) **	0.05 (.02) **	0.05 (.02) **	0.05 (.02) **
Traumatic events	-0.00 (.01)	-0.00 (.01)	-0.00 (.01)	-0.00 (.01)
Baseline controlled ^c	0.31 (.04) ***	0.31 (.04) ***	0.31 (.04) ***	0.31 (.04) ***
R ²	0.24 ***	0.24 ***	0.24 ***	0.24 ***

WTC, World Trade Center Disaster. PTSD, posttraumatic stress disorder.

^a All calculations based on weighted data & take into account the sampling design.

^b Other variables in the models: age, education, gender, marital status, race/ethnicity, income, and number of physical diseases.

^c Baseline doctor visit measure controlled in final models.

[†] $P < .10$, two-tailed t -test.

* $P < .05$, two-tailed t -test.

** $P < .01$, two-tailed t -test.

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