

Longitudinal Study of the Impact of Psychological Distress Symptoms on New-Onset Upper Gastrointestinal Symptoms in World Trade Center Responders

LEIGHANN LITCHER-KELLY, PhD, YVETTE LAM, MD, JULIE A. BROIHIER, MA, DOUGLAS L. BRAND, MD, SUVIN V. BANKER, DO, ROMAN KOTOV, PhD, EVELYN BROMET, PhD, JUAN CARLOS BUCOBO, MD, ROBERT D. SHAW, MD, AND BENJAMIN J. LUFT, MD

Objectives: Research on the health of workers involved in the cleanup after the attack on the World Trade Center (WTC) on September 11, 2001, has documented high rates of psychological distress and upper gastrointestinal (GI) symptoms. The current article examines the concurrent and longitudinal associations of psychological distress with development of new-onset upper GI symptoms in a large sample of WTC responders. **Methods:** A cohort of 10,953 WTC responders monitored by the WTC Health Program participated in the study. Two occupational groups were examined, police and nontraditional responders. The cohort was free of upper GI symptoms or diagnoses at their first visit (3 years after September 11, 2001). Logistic regression was used to analyze the relationships between concurrent and preceding psychological distress symptoms of depression, generalized anxiety, panic, and probable posttraumatic stress disorder with the development of new-onset upper GI symptoms at 3-year follow-up (6 years after September 11, 2001). **Results:** Across both occupation groups, psychological distress symptoms at Visit 1 were significantly related to the development of GI symptoms by Visit 2 (odd ratios ranging from 1.9 to 5.4). The results for the concurrent relationships were similar. In addition, there were significant dose-response relationships between the number of co-occurring psychological distress symptoms at Visits 1 and 2, and increased new-onset upper GI symptoms at Visit 2. **Conclusions:** In this large sample of WTC responders, psychological distress symptoms assessed at 3 years after 9/11 are related to reporting upper GI symptoms 6 years after 9/11. **Key words:** gastroesophageal reflux symptoms, upper gastrointestinal symptoms, WTC, psychological distress symptoms.

BMI = body mass index; **GI** = gastrointestinal; **PTSD** = posttraumatic stress disorder; **WTC** = World Trade Center; **WTC-HP** = World Trade Center Health Program.

INTRODUCTION

The 2001 World Trade Center (WTC) attack led not only to immediate deaths and injuries on September 11, 2001, but also to a massive rescue and cleanup effort, involving more than 60,000 police, firefighters, contract workers, and volunteers at Ground Zero and associated sites. This effort involved the recovery of human remains and cleanup of debris over a 9-month period, an unprecedented traumatic experience for those who were early responders to the site. Although the 9/11 disaster is often conceptualized as one event, for those involved in the cleanup effort, it was actually a series of traumatic events, sustained over months and experienced in the midst of grieving for lost colleagues and friends. Understanding the relationship between physical and mental health consequences of this event is important in the effort to improve the overall quality of life and well-being of these brave men and women and in assisting others involved in future catastrophic events.

Upper gastrointestinal (GI) symptoms (which may include gastroesophageal reflux disease [GERD] or gastroesophageal reflux symptoms [GERS]) are among the most prevalent physical health problems of WTC responders (1,2). Wisnivesky et al. (3)

reported that the most common GI disorder among WTC responders is symptoms of GERD and that symptoms of GERD persist over time. Possible reasons for the development and continuation of GERD symptoms may be the physical exposures of 9/11 (particles in the air from the debris pile that were ingested as well as inhaled (4)) and/or the psychological distress experienced by early responders.

Psychological consequences of the 9/11 disaster have been reported (3,5), and several studies have examined the relationships between physical and psychological symptoms in WTC site workers (3,6–8). Brackbill and colleagues (6) reported on 46,000 people enrolled in the WTC Health Registry (responders, persons with a primary residence in lower Manhattan, and office workers) and found that 36% of people with postevent asthma also had probable posttraumatic stress disorder (PTSD). Li and colleagues (7), using the same registry, reported a higher incidence of GERS for people with comorbid asthma and/or PTSD. Wisnivesky et al. (3) reported that 42.7% of patients with GERS seen at the WTC Medical Monitoring and Treatment Program, now known as the WTC Health Program (WTC-HP), had at least one mental health diagnosis (depression, panic, or PTSD) over a 9-year period. Luft et al. (8) also examined a cohort of patients seen at the WTC-HP and reported that probable PTSD may mediate the relationship between WTC exposures and respiratory symptoms.

The theoretical basis for the relationship between psychological distress and GI symptoms is well described in Dr. Douglas Drossman's (9) article that was adapted from his 1997 presidential address to American Psychosomatic Society. Using the framework of the biopsychosocial model, it is possible to examine how environmental exposures, genetic predispositions, and psychological factors all affect physical health, including upper GI symptoms. In support of this model, previous animal and human studies have shown changes in colonic motility and upper reflux symptoms before and after an experimental stressor (9).

In line with these laboratory studies, previous research in trauma populations, soldiers, and veterans has also demonstrated

From the Departments of Psychiatry (L.L.-K., R.K., E.B.) and Medicine (J.A.B., B.J.L.), Stony Brook University, Stony Brook, New York; Department of Medicine (L.L.-K., D.L.B., S.V.B., J.C.B., R.D.S.), Division of Gastroenterology and Hepatology, Gastrointestinal Motility Center, Stony Brook University, Stony Brook, New York; Division of Gastroenterology and Hepatology (Y.L.), Downstate Medical Center, State University of New York, Brooklyn, New York; and Gastroenterology Service (R.D.S.), Northport Veterans Affairs Medical Center, Northport, New York.

Address correspondence and reprint requests to Leighann Litcher-Kelly, PhD, Departments of Psychiatry and Medicine, Division of Gastroenterology and Hepatology, Stony Brook University, T-10, Room 040, Stony Brook, NY 11794-8101. E-mail: Leighann.Litcher@stonybrookmedicine.edu

Received for publication October 17, 2013; revision received August 10, 2014.

DOI: 10.1097/PSY.0000000000000116

a relationship between psychological distress and GI symptoms (10–13). Studies of veterans of the Persian Gulf War and the conflicts in Iraq and Afghanistan have shown that a PTSD diagnosis significantly increases risk of digestive disorders (10–12). Similarly, population-based studies have shown that people with a history of sexual and physical abuse also have high rates of GI symptoms (14,15). In addition, previous studies that have focused on people affected by the WTC attacks specifically have reported high rates of both upper GI symptoms and psychological distress. Given the literature showing high rates of GI symptoms in other traumatized groups, the high rates of upper GI symptoms in WTC responders, occurring years after the event, may be related to the psychological distress emanating from the 9/11 event.

The importance of understanding the relationship between physical and psychological symptoms in WTC responders is well recognized (16). Because of the high rates of probable PTSD reported by other WTC studies, particularly in nontraditional responders compared with police, along with other studies documenting that psychological distress not only can complicate care and amelioration of physical symptoms but also may contribute to the development of physical health conditions, it is essential to study both physical and psychological symptoms in these individuals.

Therefore, this secondary analysis of data from the WTC-HP examines the relationships between psychological distress symptoms and self-reported upper GI symptoms reported during two visits to the WTC-HP clinic. Specifically, we first examined the concurrent relationship between psychological distress symptoms and new-onset upper GI symptoms reported at the second clinic visit to the WTC-HP. Second, to understand the longitudinal relationship, we examined how psychological distress symptoms reported at the first clinic visit (on average 3.7 years after 9/11) increased the risk of reporting upper GI symptoms at a second clinic visit (approximately 6 years post-9/11), after controlling for major risk factors such as obesity and smoking (17,18), demographic factors, WTC exposures, and Visit 2 psychological distress symptoms. All analyses are stratified by occupation (nontraditional responder versus police responder) because previous analyses of this cohort of WTC responders have shown differences in psychological distress symptoms between professionally trained responders, who may have had special training and previous experience with highly stressful environments, and nontraditional responders (8,19,20). The current analyses address the following hypotheses:

- Psychological distress symptoms reported at Visit 2 will be related to new-onset upper GI symptoms also reported at Visit 2, in both occupational groups.
- Psychological distress symptoms of depression, anxiety, panic, and PTSD at Visit 1 will increase the risk of reporting upper GI symptoms at Visit 2 in both police and nontraditional responders, when controlling for psychological distress symptoms reported at Visit 2.
- Reporting psychological distress symptoms in multiple domains will increase risk of new-onset upper GI symptoms in both occupational groups.

METHODS

Study Population

The WTC-HP was funded by the Centers for Disease Control and Prevention/ National Institute for Occupational Safety and Health to track the health of responders to the WTC attack in New York City not covered by other federally funded monitoring programs. The WTC-HP conducted extensive outreach to publicize the availability of its five centers in New York and New Jersey, including attending union meetings, mailings, telephone calls, and the use of print and broadcast media.

Institutional review boards at each site approved and monitored compliance for research procedures and protections of human subjects. All patients seen in the clinics provided written informed consent at each visit to allow collection of information for clinical and research purposes. The current sample includes 18,896 responders with information from Visits 1 and 2, and 7% had already developed upper GI symptoms by Visit 1. All of these records were excluded, resulting in the analysis sample of 10,953 responders who have complete upper GI symptom data at Visits 1 and 2, after excluding those with a history of upper GI symptoms either before 9/11/2001 or with onset between 9/11/2001 and Visit 1. Response rates for the psychological distress variables vary, and the number of participants with data for these measures at Visits 1 and 2 is included below under “Materials/Measures” and in Tables 3 and 4, which summarize the logistic regression analyses.

Materials/Measures

The first visit to the WTC-HP occurred approximately 3 to 4 years after 9/11/2001 (mean [standard deviation] = 3.7 [2.2] years), and the second visit occurred approximately 3 years after Visit 1 (mean [standard deviation] = 6.3 [1.9] years after 9/11). During both visits to the clinic, participants provided an extensive medical history (including questions about upper GI symptoms), a physical examination, and self-report questionnaires assessing demographic information and psychological symptoms. Exposure information was obtained at Visit 1.

Upper GI Symptoms

During the medical history, the physician asked the participant if he/she had received a diagnosis of GERD from a physician *after 9/11/2001*. As noted above, responders who reported a diagnosis of GERD at Visit 1 were excluded from the analysis. To corroborate the patients’ self-reported GERD diagnosis at Visit 2, this information was compared with self-reported upper GI symptom data that were also ascertained at Visit 2. Both heartburn and reflux into the mouth were reported significantly more in the group of patients who self-identified as having a GERD diagnosis at Visit 2 (odds ratio [OR] = 7.9, 95% confidence interval [CI] = 6.7–9.3, $p \leq .001$ for heartburn; OR = 10.5, 95% CI = 8.8–12.5, $p \leq .001$ for reflux into mouth). Because we do not have verification of GERD diagnoses, we conservatively characterize this group as patients who developed new-onset upper GI symptoms at Visit 2. Of the total sample of 10,953 participants, 15.6% reported new-onset upper GI symptoms reported at WTC-HP clinic Visit 2, and 33.5% and 26.9% self-reported heartburn and reflux symptoms at Visit 2, respectively.

Demographic and Exposure Information

During Visit 1, the physician completed a physical examination, computed body mass index (BMI) to assess obesity (defined here as BMI of 30+ kg/m²), and ascertained smoking history and exposure information (length of time and dates the patient worked on the site, as well as work site locations and exposures to bodily remains, dust, and search/rescue operations). In addition, each patient completed a demographic questionnaire. See Table 1 for demographic and exposure variables included in the analyses.

Psychological Distress Symptoms

Participants completed the following self-report questionnaires during Visits 1 and 2.

1. Depression Symptoms: Depression symptoms were assessed using the Patient Health Questionnaire (PHQ-9) ((21), which measures the cardinal symptoms of major depression rated for the last 2 weeks and scored on a 4-point scale (0 = not at all to 3 = nearly every day; range for continuous score, 0–27). Scores below

TABLE 1. Baseline Demographic Characteristics and 9/11 Exposures by Occupational Group

	Nontraditional Responders			Police Responders		
	No Upper GI Symptoms (<i>n</i> = 4613)	Upper GI Symptoms (<i>n</i> = 956)	<i>p</i> Level	No Upper GI Symptoms (<i>n</i> = 4683)	Upper GI Symptoms (<i>n</i> = 701)	<i>p</i> Level
Work status, % full time	72.1	56.6	<.001	83.0	76.0	<.001
Education, % some college or more	75.2	72.5	.31	96.4	98.4	.43
Sex, % female	12.3	18.2	<.001	14.5	17.1	.07
Marital status, % married	80.5	80.5	.99	83.7	83.8	.98
Income, % >\$60,000	46.8	37.7	<.001	75.1	72.7	.19
Race, % white	77.2	80.6	.06	79.1	81.4	.22
Age on 9/11/01, M (SD), y	40.5 (9.8)	40.9 (9.5)	.20	36.5 (6.9)	36.9 (6.8)	.17
BMI, % obese	36.5	40.7	.06	42.4	47.6	.03
Smoking, % current	19.7	21.9	.17	9.1	8.5	.73
Arrival date on 9/11/01, %	31.6	30.0	.43	59.5	62.2	.22
Dust on 9/11, % yes	12.8	12.4	.75	27.0	27.8	.22
Human remains, % yes	36.3	35.8	.78	62.8	62.6	.93
Search/Rescue, % yes	5.5	6.6	.20	17.1	20.5	.03
Work long hours, % >75 percentile	25.2	27.3	.17	21.1	22.5	.38
Work site 9/11, % on/near pile	90.0	92.5	.03	84.4	85.9	.32
Years between 9/11 and Visit 1, M (SD)	3.9 (2.1)	4.4 (1.9)	<.001	4.9 (2.0)	4.9 (1.9)	.55

GI = gastrointestinal; BMI = body mass index.

New-onset GI symptoms were determined at Visit 2.

5 indicate no depression; 5 to 9, mild depression; 10 to 14, moderate depression; 15 to 19, moderately severe depression; and 20+, severe depression (21). A dichotomous measure for depression was used in the analyses: none/mild versus moderate/severe depression (21).

- a. The current data set includes 9653 participants who have depression scores at Visit 1 and 5243 who have depression scores at Visit 2.
2. Generalized Anxiety Symptom: The symptoms of anxiety was based on responses to the following PHQ item: "Over the past 2 weeks, how often were you bothered by feeling nervous, anxious, or on edge?" (22). The rating scale was the same as for the depression item, but a dichotomized variable was used in the analyses (not at all versus several days/more than half the days/nearly every day).
 - a. There are 10,377 participants who have data on this anxiety question at Visit 1 and 5520 who have data from Visit 2.
3. Panic symptoms: To determine whether participants were experiencing symptoms of panic disorder, the five panic items from the PHQ were used (must have endorsed yes to panic attacks and responded yes to 2 of the 4 remaining questions (21,23)).
 - a. There are 10,241 participants who have data on this panic scale at Visit 1 and 5551 participants who have data from Visit 2.
4. Probable PTSD symptoms: The civilian version of the PTSD Checklist (PCL) (24) was modified to anchor responses to WTC-related experiences. The PCL is a widely used and validated measure that assesses the 17 DSM-IV criterion symptoms of PTSD over the last month, which are rated from 1 (not at all) to 5 (extremely). These items include "Repeated, disturbing memories, thoughts or images"; "Feeling very upset when something reminded you of a stressful experience"; and "Feeling emotionally numb or being unable to have loving feelings for those close to you." The total PTSD score is calculated by summing the 17 items (range, 17–85). Probable PTSD was defined as a score of 50 or greater, which has been used in previous WTC studies assessing PTSD (8).
 - a. There are 10,433 participants who have PTSD total scores from Visit 1 and 9893 who have data from Visit 2.
5. The total number of co-occurring psychological distress symptoms ratings exceeding established cut-points reported at Visits 1 and 2 (composite distress index): The cut-points are as follows: 10+ on the PHQ-9 depression

measure, presence of generalized anxiety, met the criteria for panic disorder, and a score of 50+ on the PCL. Thus, the composite distress index ratings have a range of 0 to 4 and were computed for psychological distress reported at Visits 1 and 2.

Statistical Analysis

The data were analyzed using SPSS Version 19, and graphs were generated using both SPSS V.19 and Microsoft Excel 2010. Previous studies on WTC responders documented significant differences with regard to health outcomes and also WTC exposures between police and nonpolice for psychological distress symptoms (3,8,19); therefore, as noted earlier, the analyses stratify on occupation.

To validate the upper GI symptoms question asked at Visit 2, ORs with 95% CIs were computed to examine how this variable was related to the presence of two classic upper GI symptoms: heartburn and reflux into the mouth.

χ^2 Test and analysis of variance were used to examine the demographic and exposure covariate measures, stratified by occupation on 9/11 (Table 1). Before the main hypothesis was tested, nonparametric Spearman ρ correlations were computed between the categorical psychological distress measures to ensure that these variables are assessing distinct constructs (Table 2). These covariates were entered into the logistic regression models for the primary analyses examining how psychological distress affects new-onset upper GI symptoms.

To test the concurrent relationship between psychological distress symptoms and new-onset upper GI symptoms reported at Visit 2, multivariate logistic regression was used that controlled for the demographic and exposure covariates listed in Table 1 and psychological distress reported at Visit 1. Each of the psychological distress categorical variables (depression, anxiety, panic, and probable PTSD symptoms) was analyzed in separate regression models. The number of co-occurring psychological distress symptoms variables scored above the published cut-points (composite distress index) was also analyzed in the same way to determine if there was a dose-response relationship between number of mental health risk indices and new-onset upper GI symptoms, adjusting for covariates.

To examine the longitudinal relationship (i.e., the hypothesis that psychological distress symptoms reported at Visit 1 will increase the risk of new-onset upper GI symptoms at Visit 2), again multivariate logistic regression analysis

PSYCHOLOGICAL & GI SYMPTOMS IN WTC RESPONDERS

TABLE 2. Association Between Psychological Measures at 3 and 6 Years After September 11, 2011^a

		Psychological Distress Symptoms			
		Depression Symptoms	Anxiety Symptoms	Panic Symptoms	PTSD Symptoms
Psychological distress symptoms	Depression symptoms	0.49	0.50	0.35	0.59
	Anxiety symptoms	0.48	0.41	0.31	0.49
	Panic symptoms	0.32	0.29	0.40	0.40
	PTSD symptoms	0.64	0.44	0.30	0.54

PTSD = posttraumatic stress disorder.

^a Nonparametric Spearman ρ correlations among categorical psychological distress measures reported at Visits 1 and 2 (all are significant at $p < .001$). The diagonal shaded cells show the longitudinal relationship for each of the psychological symptoms. Above this diagonal are the correlations among the psychological distress symptoms from the concurrent data collected at Visit 1. Below the diagonal are the concurrent correlations for the Visit 2 data.

was implemented, adjusting for all covariates identified in Table 1 and psychological distress symptoms reported at Visit 2. Similar to analyses for the concurrent relationships, each psychological distress categorical variable was analyzed in separate regression models.

RESULTS

Table 1 summarizes the demographic characteristics and WTC exposures for participants with and without upper GI symptoms, stratified by occupation. Across both occupational groups, significantly fewer WTC responders with new-onset GI symptoms currently worked full-time. For nontraditional responders, there were also significant differences between the GI groups on sex (more women reported GI symptoms), income, working on the pile in September 2001, and length of time between 9/11 and initial WTC-HP clinic visit. For the police group, responders with new-onset upper GI symptoms were more likely to be obese and to have worked in search and rescue operations. Because all the covariates listed in Table 1 are theoretically related to differences in both psychological distress and presence of upper GI symptoms, all covariates were included in the logistic regression analyses described below.

Before examining the concurrent and longitudinal relationships between psychological distress symptoms reported at Visits

1 and 2 and new-onset upper GI symptoms reported at Visit 2, nonparametric correlations among the categorical psychological distress variables were examined. This was to ensure that each measure of distress was, in fact, assessing a distinct construct. Table 2 summarizes the nonparametric Spearman ρ correlations for the categorical variables assessing depression, anxiety, panic, and PTSD symptoms. The correlations for the concurrent assessments summarize self-reported data on each of the psychological construct, as reported at one visit. The concurrent data from Visit 1 appear above the diagonal line, whereas concurrent data from Visit 2 are below the diagonal line. Longitudinal data, self-reported for each psychological construct at both time points, appear within the diagonal line and are shaded gray. Both the concurrent and the longitudinal correlations are modest (given Cohen's definition of small to moderate correlations) (25). Effect sizes for the concurrent assessments ranged from 0.29 to 0.64, with most between 0.3 and 0.4. The effect sizes for the longitudinal assessments were similar, ranging from 0.28 to 0.54. Given these moderate correlations, each psychological symptom measure was analyzed in separate logistic regression analyses.

Analysis of Nontraditional Responders

Among nontraditional responders, 17.2% reported new-onset upper GI symptoms at Visit 2. As shown in Table 3, self-reported

TABLE 3. Nontraditional Responders: Psychological Distress Variables Reported at Visits 1 and 2, for Participants With and Without Upper GI Symptoms at Visit 2^a

	No Upper GI Symptoms	Upper GI Symptoms	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratios (95% CI)
Depression symptoms at Visit 1	20.9% (3951)	41.5% (797)	2.7 (2.3–3.2)***	2.5 (1.6–4.0)***
Depression symptoms at Visit 2	24.7% (1832)	46.2% (407)	2.6 (2.1–3.3)***	3.2 (1.7–6.2)***
Anxiety symptom at Visit 1	35.3% (4362)	57.0% (906)	2.4 (2.1–2.8)***	2.6 (1.8–3.8)***
Anxiety symptoms at Visit 2	51.5% (1952)	71.5% (438)	2.4 (1.9–3.0)***	3.1 (1.6–5.9)***
Panic symptoms at Visit 1	8.6% (4285)	19.0% (879)	2.5 (2.1–3.1)***	1.9 (1.1–3.4)*
Panic symptoms at Visit 2	9.4% (1969)	24.8% (443)	3.2 (2.4–4.1)***	3.6 (1.6–8.2)**
PTSD symptoms at Visit 1	17.7% (4366)	37.6% (909)	2.8 (2.4–3.3)***	2.3 (1.5–3.5)***
PTSD symptoms at Visit 2	20.8% (4144)	42.8% (821)	2.9 (2.4–3.3)***	3.1 (2.0–4.9)***

GI = gastrointestinal; PTSD = posttraumatic stress disorder; CI = confidence interval.

Sample size is in parentheses.

* $p < .05$, ** $p < .01$, *** $p < .001$.

^a Logistic regression predicting new-onset upper GI symptoms at Visit 2 from each psychological measure. Adjusted odds ratios control for all covariates listed in Table 1; Visit 2 psychological distress analyses also control for Visit 1 psychological distress.

psychological distress, reported at Visits 1 and 2, was significantly associated with new-onset upper GI symptoms reported at Visit 2. In addition, there was a significant dose-response relationship between the composite distress index for psychological distress reported at Visits 1 and 2 and the risk of new-onset upper GI symptoms reported at Visit 2 (Fig. 1 [$\chi^2(4) = 219.1, p < .001$] and Fig. 2 [$\chi^2(4) = 50.4, p < .001$]).

Analyses of Police Responders

The analyses above were repeated for the sample of participants who were police officers on 9/11. Thirteen percent of the police responders reported new-onset upper GI symptoms at Visit 2. Compared with the nontraditional responders, Table 4 shows that police responders reported less psychological distress symptoms for each of the measures during both Visits 1 and 2 to the WTC-HP clinic. Nonetheless, with the exception of anxiety symptom (reported at Visits 1 and 2) and depression symptoms (reported at Visit 2), each distress measure was significantly associated with new-onset upper GI symptoms in the police responders, for both the concurrent and longitudinal analyses. In addition, we found significant dose-response relationships for the psychological distress composite index for both Visits 1 and 2, and upper GI symptoms, at both Visits 1 and 2 (Fig. 1 [$\chi^2(4) = 60.0, p < .001$] and Fig. 2 [$\chi^2(4) = 25.5, p < .001$]).

Rates of Upper GI Symptoms and Psychological Distress in WTC-HP Compared With Previously Reported Rates in Epidemiological Samples

Figure 3 compares the Visit 2 self-reported rates of upper GI symptoms and the measured rates of psychological distress symptoms found in the current sample with published rates for the general population (26,27). The first three bars of the figure show new-onset upper GI symptoms, heartburn, and reflux into the mouth within the previous 12 months occurring at rates of 15.6%, 33.5%, and 26.9%, respectively. This is compared with a rate of 20% for upper GI symptoms reported in an epidemiological sample (26). The rates for depression, anxiety, and PTSD for the

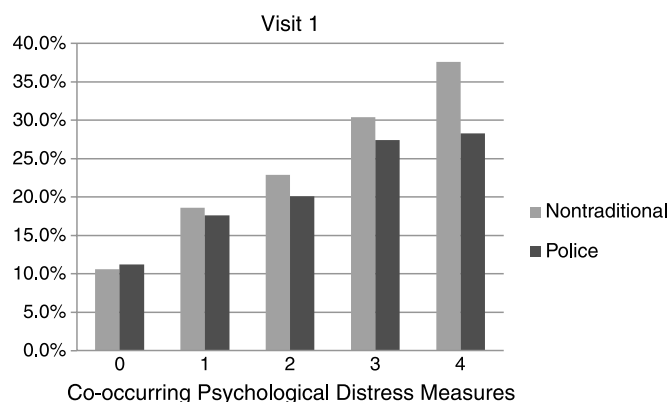


Figure 1. Dose-response relationship between number of co-occurring psychological distress measures scored over the published cut-points (composite distress index) reported at Visit 1 and percentage of participants with new-onset upper GI symptoms at Visit 2, by occupational group. GI = gastrointestinal.

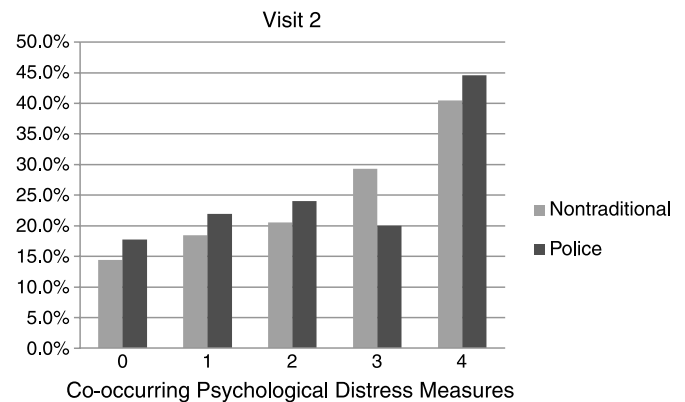


Figure 2. Dose-response relationship between number of co-occurring psychological distress measures scored over the published cut-points (composite distress index) reported at Visit 2 and percentage of participants with new-onset upper GI symptoms at Visit 2, by occupational group. GI = gastrointestinal.

current sample for Visits 1 and 2 are compared with the general population (27) in Figure 3.

DISCUSSION

Given the traumatic events and intense stress surrounding the 9/11 attacks and the literature linking trauma, psychological factors, and GI symptoms (28), it is not surprising that many WTC responders report psychological and upper GI symptoms. The work environment was fraught with predictable stressors, such as long work shifts, but also unprecedented stressors, such as taking part in the search and rescue efforts for friends and colleagues. In this regard, our findings of elevations in psychological distress in WTC responders, years after the event, are similar to those of previously published studies (5,7,19,29).

Our primary finding in this secondary analysis of WTC-HP data is that psychological distress reported 3 to 4 years after 9/11 increased the risk of reporting new-onset upper GI symptoms, approximately 6 years after 9/11, in both police and nontraditional WTC responders. In addition, we found that the concurrent relationship between psychological distress and upper GI symptoms reported at Visit 2 is quite similar in strength to the longitudinal relationship between previous distress predicting new-onset upper GI symptoms. This is in agreement with findings by Li et al. (7), who reported in a recent retrospective analysis that the presence of PTSD increases the risk of persistent GERSs. We extend Li and colleagues' finding by showing that psychological distress is a risk for the *new-onset* of upper GI symptoms, as we had the ability to eliminate participants who reported a history of GI symptoms, either before 9/11/2001 or between 9/11 and Visit 1 to the WTC-HP. In addition, the current study also documents that, in addition to PTSD, other psychological symptoms of distress are related to new-onset upper GI symptoms, including depression, anxiety (in nontraditional responders), and panic. Finally, we found that multiple psychological distress factors increased risk of upper GI symptoms in a dose-response fashion, even after controlling for WTC physical exposure variables, and common variables related to upper GI symptoms, such as BMI and smoking.

PSYCHOLOGICAL & GI SYMPTOMS IN WTC RESPONDERS

TABLE 4. Police Responders: Psychological Distress Variables at Visits 1 and 2, for Participants With and Without Upper GI Symptoms at Visit 2^a

	No Upper GI Symptoms	Upper GI Symptoms	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratios (95% CI)
Depression symptoms at Visit 1	5.8% (4268)	12.1% (627)	2.2 (1.7–2.9)***	2.9 (1.3–6.3)**
Depression symptom at Visit 2	8.2% (2597)	17.2% (407)	2.3 (1.7–3.1)***	2.5 (0.9–6.4)
Anxiety symptom at Visit 1	14.8% (4449)	22.7% (660)	1.7 (1.4–2.1)***	1.7 (0.9–3.1)
Anxiety symptom at Visit 2	28.6% (2708)	47.2% (422)	2.2 (1.8–2.7)***	1.6 (0.8–3.2)
Panic symptom at Visit 1	3.4% (4417)	8.0% (660)	2.5 (1.8–3.4)***	4.5 (1.8–11.3)***
Panic symptom at Visit 2	3.6% (2713)	12.2% (426)	3.7 (2.6–5.3)***	5.4 (1.8–16.0)**
PTSD symptoms at Visit 1	4.8% (4491)	10.6% (667)	2.3 (1.8–3.1)***	3.1 (1.4–6.9)**
PTSD symptom at Visit 2	6.1% (4298)	17.5% (630)	3.2 (2.5–4.1)***	2.7 (1.3–5.8)**

GI = gastrointestinal; PTSD = posttraumatic stress disorder; CI = confidence interval.

Sample size is in parentheses.

** $p < .01$, *** $p < .001$.

^a Logistic regression predicting new-onset upper GI symptoms at Visit 2 from each psychological measure. Adjusted odds ratios control for all covariates listed in Table 1; Visit 2 psychological distress analyses also control for Visit 1 psychological distress.

The analyses were stratified by police occupation because of previously reported data that police differed from other nontraditional responders with regard to psychological distress, perhaps due to training and previous experiences, along with the selection bias of the police academy for psychologically healthy individuals. All this may have made those in the police group better prepared to cope with the devastating events that happened on and after 9/11. The current analyses support this difference, in that the police group reported lower psychological distress than did the other responders, consistent with previous reports from this population (8,29). However, despite the lower rates of psychological distress in the police group, all the psychological distress measures rated at Visit 1, except for generalized anxiety, significantly increased the risk of new-onset upper GI symptoms at Visit 2. In addition, for both occupational groups, there was a significant dose-response relationship between the number of psychological distress factors at Visit 1 and increasing rates of upper GI symptoms at Visit 2.

Our study shows that the associations between the psychological distress and upper GI symptoms were consistent across the two populations. One topic for further study is to longitudinally examine the response to conventional pharmacotherapy for GERD (proton-pump inhibitors; PPI) in WTC responders, to ascertain the impact that psychological distress may have in GERD treatment response.

An important strength of the current study is the large number of participants who were free of upper GI symptoms at Visit 1, which allowed us to identify participants with new-onset upper GI symptoms at Visit 2. Another strength is the use of well-validated, standardized measures of psychological distress symptoms that were assessed both before the onset of and concurrent with upper GI symptoms. Although these psychological measures are not intended to be used for diagnosing mental disorders, they have well-validated, clinically meaningful published cut-points that can be used in applied research. This current study's longitudinal data enabled us to examine how psychological distress symptoms, experienced after 9/11 but before the development

of GI symptoms, affect the risk of subsequently developing upper GI symptoms, after controlling for covariates.

A limitation of the study is the demographic homogeneity of the sample. Like many samples of WTC responders, our sample was composed of mostly white, married men. However, this reflects the composition of those who were involved in the cleanup effort. Another limitation is the attrition between Visits 1 and 2. It is difficult to determine the reason for missing data from certain psychological screening questionnaires, given the nature of this secondary analysis. However, given the large sample size even after attrition, and the significant findings after controlling for many potential confounding variables, these findings warrant a prospective study designed to explicitly examine

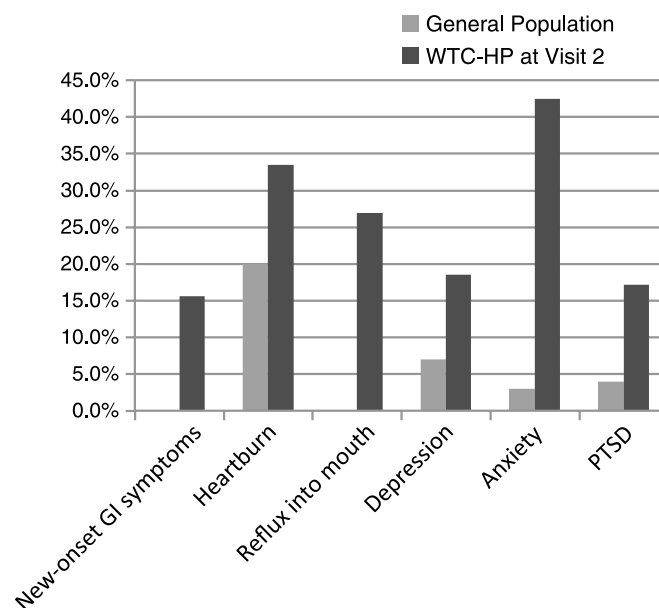


Figure 3. Comparison of rates of self-reported upper GI symptoms and psychological distress at Visit 2 in the WTC-HP sample, compared with rates in previous epidemiological studies. GI = gastrointestinal; WTC-HP = World Trade Center Health Program; PTSD = posttraumatic stress disorder.

the relationship between psychological symptoms and upper GI symptoms in WTC responders.

A second limitation is the reliance on self-report measures, in the absence of 24-hour pH or endoscopic evidence of GERD and data on PPI treatment outcomes. This prevents us from discerning whether our patients who developed upper GI symptoms have developed excessive acid reflux or a version of nonerosive reflux disease such as visceral hypersensitivity (the patient has upper GI symptoms from amounts of reflux considered normal) or functional heartburn (the patient has no definable link between heartburn and episodes of reflux). The latter two alternatives, nicely discussed in an editorial by Sayuk and Drossman (30), often are associated with a concurrent psychological condition, in which the presence of psychological stress enhances the likelihood of reporting reflux symptoms. In addition, another limitation is the use of psychological screening questionnaires, which can only assess symptoms and not whether the participants meet the criteria for a clinical diagnosis.

Our study shows that four types of psychological symptoms, when present at Visits 1 and 2, can each play a distinct role, whether present individually or in concert. Future studies should address patients similar to ours who have had objective testing for GERD and/or a well-documented trial of PPI therapy, as well as thorough psychological assessment, to more specifically identify and separate the causes of newly developed upper GI symptoms.

Understanding the psychological risk factors that are associated with the medical symptomatology in these patients may help identify individuals who are at risk for developing physical health conditions, after future traumatic events. In addition, with the understanding that psychological factors may increase the risk of upper GI symptoms, we now need to evaluate how these factors may affect treatment efficacy. Thus, future studies should also examine how psychological distress may complicate the course and treatment options for those with GI symptoms.

We are grateful to the WTC rescue and recovery workers for agreeing to participate in this research project and to the clinical staff at the WTC-H.

Source of Funding and Conflicts of Interest: This work was supported by the Centers for Disease Control and Prevention awards 200-2002-0038, 5U10 OH008232, U10 OH008225, U10 OH008216, U10 OH008223, U10 OH008239, and U10 OH008275, awarded to Drs. Luft, Bromet, and Kotov. This study was reviewed by Stony Brook University's Institutional Review Board (IRBnet number: 89876-19) and is approved for 7/15/2013 to 7/14/2014. The authors have no conflicts of interest to report.

REFERENCES

- Levin SM. Physical health status of World Trade Center rescue and recovery workers and volunteers—New York City, July 2002–August 2004. *MMWR Morbid Mortal Wkly Rep* 2004;53:807–12.
- de la Hoz RE, Christie J, Teamer JA, Bienenfeld LA, Afilaka AA, Crane M, Levin SM, Herbert R. Reflux symptoms and disorders and pulmonary disease in former World Trade Center rescue and recovery workers and volunteers. *J Occup Environ Med* 2008;50:1351–4.
- Wisnivesky JP, Teitelbaum SL, Todd AC, Boffetta P, Crane M, Crowley L, de la Hoz RE, Dellenbaugh C, Harrison D, Herbert R, Kim H, Jeon J, Kaplan J, Katz C, Levin S, Luft B, Markowitz S, Moline JM, Ozbay F, Pietrzak RH, Shapiro M, Sharma V, Skloot G, Southwick S, Stevenson LA, Udasin I, Wellenstein S, Landrigan PJ. Persistence of multiple illnesses in World Trade Center rescue and recovery workers: a cohort study. *Lancet* 2011;378:888–97.
- de la Hoz RE, Shohet MR, Chasan R, Bienenfeld LA, Afilaka AA, Levin SM, Herbert R. Occupational toxicant inhalation injury: the World Trade Center (WTC) experience. *Int Arch Occup Environ Health* 2008;81:479–85.
- Bills CB, Levy NAS, Sharma V, Charney DS, Herbert R, Moline J, Katz CL. Mental health of workers and volunteers responding to events of 9/11: review of the literature. *Mt Sinai J Med* 2008;75:115–27.
- Brackbill R, Hadler JL, DiGrande L, Ekenga CC, Farfel MR, Friedman S, Perlman SE, Stellman SD, Walker DJ, Wu D, Yu S, Thorpe LE. Asthma and posttraumatic stress symptoms 5 to 6 years following exposure to the World Trade Center terrorist attack. *JAMA* 2009;302:502–16.
- Li J, Brackbill RM, Stellman SD, Farfel MR, Miller-Archie SA, Friedman S, Walker DJ, Thorpe LE, Cone J. Gastroesophageal reflux symptoms and comorbid asthma and posttraumatic stress disorder following the 9/11 terrorist attacks on World Trade Center in New York City. *Am J Gastroenterol* 2011;106:1933–41.
- Luft B, Schechter C, Kotov R, Brohier J, Reissman D, Guerrero K, Udasin I, Moline J, Harrison D, Friedman-Jimenez G, Pietrzak RH, Southwick SM, Bromet EJ. Exposure, probable PTSD and lower respiratory illness among World Trade Center rescue, recovery and clean-up workers. *Psychol Med* 2012;42:1069–79.
- Drossman DA. Gastrointestinal illness and the biopsychosocial model. *Psychosom Med* 1998;60:258–67.
- Wolfe J, Schnurr PP, Brown PJ, Furey J. Posttraumatic stress disorder and war-zone exposure as correlates of perceived health in female Vietnam war veterans. *J Consult Clin Psychol* 1994;62:1235–40.
- Proctor S, Heeren T, White R, Wolfe J, Borgos M, Davis J, Pepper L, Clapp R, Sutker PB, Vasterling JJ, Ozonoff D. Health status of Persian Gulf War veterans: self-reported symptoms, environmental exposures and the effect of stress. *Int J Epidemiol* 1998;27:1000–10.
- Andersen J, Wade M, Possemato K, Ouimette P. Association between posttraumatic stress disorder and primary care provider-diagnosed disease among Iraq and Afghanistan veterans. *Psychosom Med* 2010;72:498–504.
- Dunphy RC, Bridgewater L, Price DD, Robinson ME, Zeilman CJ III, Verne GN. Visceral and cutaneous hypersensitivity in Persian Gulf war veterans with chronic gastrointestinal symptoms. *Pain* 2003;102:79–85.
- Jansson C, Nordenstedt H, Wallander MA, Johansson S, Johnsen R, Hveem K, Lagergren J. Severe gastro-oesophageal reflux symptoms in relation to anxiety, depression and coping in a population-based study. *Aliment Pharmacol Ther* 2007;26:683–91.
- Mizyed I, Fass SS, Fass R. Review article: gastro-oesophageal reflux disease and psychological comorbidity. *Aliment Pharmacol Ther* 2009;29:351–8.
- Perlman SE, Friedman S, Galea S, Nair HP, Eros-Sarmay M, Stellman SD, Hon J, Greene CM. Short-term and medium-term health effects of 9/11. *Lancet* 2011;378:925–34.
- El-Serag H. The association between obesity and GERD: a review of the epidemiological evidence. *Dig Dis Sci* 2008;53:2307–12.
- Locke GR, Talley NJ, Fett SL, Zinsmeister AR, Melton LJ 3rd. Risk factors associated with symptoms of gastroesophageal reflux. *Am J Med* 1999;106:642–9.
- Perrin M, DiGrande L, Wheeler K, Thorpe L, Farfel M, Brackbill R. Differences in PTSD prevalence and associated risk factors among World Trade Center Disaster rescue and recovery workers. *Am J Psychiatry* 2007;164:1385–94.
- Herbert R, Moline J, Skloot G, Metzger K, Baron S, Luft B, Markowitz S, Udasin I, Harrison D, Stein D, Todd A, Enright P, Stellman JM, Landrigan PJ, Levin SM. The World Trade Center disaster and the health of workers: five-year assessment of a unique medical screening program. *Environ Health Perspect* 2006;114:1853–8.
- Spitzer RL, Williams JBW, Kroenke K, Hornyak R, McMurray J. for the Patient Health Questionnaire Obstetrics-Gynecology Study G. Validity and utility of the PRIME-MD Patient Health Questionnaire in assessment of 3000 obstetric-gynecologic patients: the PRIME-MD Patient Health Questionnaire Obstetrics-Gynecology Study. *Am J Obstet Gynecol* 2000;183:759–69.
- Spitzer R, Kroenke K, Williams JW, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med* 2006;166:1092–7.
- Rief W, Nanke A, Klaiberg A, Braehler E. Base rates for panic and depression according to the Brief Patient Health Questionnaire: a population-based study. *J Affect Disord* 2004;82:271–6.

PSYCHOLOGICAL & GI SYMPTOMS IN WTC RESPONDERS

24. Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM. The PTSD Checklist (PCL): Reliability, Validity, and Diagnostic Utility. Paper presented at the Ninth Annual Conference of ISTSS; San Antonio, TX; 1993.
25. Cohen J. A Power Primer. *Psychol Bull* 1992;112:155–9.
26. Locke GR, Talley NJ, Fett SL, Zinsmeister AR, Melton LJ 3rd. Prevalence and clinical spectrum of gastroesophageal reflux: a population-based study in Olmsted County, Minnesota. *Gastroenterology* 1997;112:1448–56.
27. Kessler R, Chiu W, Demler O, Walters EE. Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the national comorbidity survey replication. *Arch Gen Psychiatry* 2005;62:617–27.
28. Drossman DA. Abuse, trauma, and GI illness: is there a link? *Am J Gastroenterol* 2011;106:14–25.
29. Stellman JM, Smith RP, Katz CL, Sharma V, Charney DS, Herbert R, Moline J, Luft BJ, Markowitz S, Udasin I, Harrison D, Baron S, Landrigan PJ, Levin SM, Southwick S. Enduring mental health morbidity and social function impairment in World Trade Center rescue, recovery, and cleanup workers: the psychological dimension of an environmental health disaster. *Environ Health Perspect* 2008;116:1248–53.
30. Sayuk GS, Drossman DA. Editorial: gastroesophageal reflux symptoms in 9/11 survivors and workers: insights gained from tragic losses. *Am J Gastroenterol* 2011;106:1942–5.