

Patterns and Predictors of Trajectories of Depression after an Urban Disaster

ARIJIT NANDI, PhD, MELISSA TRACY, MPH, JOHN R. BEARD, MBBS, PhD,
DAVID VLAHOV, PhD, AND SANDRO GALEA, MD, DRPH

PURPOSE: To identify and understand the patterns and predictors of depressive symptom trajectories over time after mass traumatic events.

METHODS: Data were used from a prospective, representative sample of adult residents of the New York City metropolitan area ($N = 2,282$) followed up across four survey waves between 2001 (after the September 11 attacks) and 2004. Semi-parametric group-based modeling was used to identify trajectories, as well as the time-fixed and time-varying predictors of distinct depressive trajectories.

RESULTS: Five distinct trajectories of depression were characterized: minimal symptomatology at all time points (group 1, 39% of sample), mild delayed depression (group 2, 34% of sample), recovery (group 3, 6% of sample), severe delayed depression (group 4, 13% of sample), and chronic severe depression (group 5, 8% of sample). Among members of distinct trajectories, lower household income, exposure to ongoing stressors, and exposure to traumatic events were commonly associated with an increased number of depressive symptoms.

CONCLUSIONS: Ongoing socioeconomic adversity appears to be centrally associated with a worse course of depression after exposure to traumatic events. Identifying distinct trajectories of depression and the preventable factors that are associated with them may facilitate the development of interventions that aim to promote better mental health.

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INTRODUCTION

A growing body of epidemiologic research has assessed the burden of depressive psychopathology following exposure to disasters (1–10), as well as in populations with increased exposure to traumatic events, including war veterans (11) and refugees (12–14). While comparisons across studies are complicated by substantial heterogeneity in the type of disaster, sample, and study design, cross-sectional research suggests that depressive symptomatology may be elevated in the immediate aftermath of a disaster, particularly among those with greater exposure to the event (4, 5, 7, 8). Results from prospective studies, in contrast, have been

inconsistent, limiting inference regarding longitudinal patterns of depression after disasters. For example, some studies have observed a rapid resolution of depressive symptoms after exposure to mass trauma (1), whereas other work has shown a persistent burden with little evidence of recovery (2, 6).

Recent findings show that multiple subgroups may exist among those exposed to mass trauma, including those who are consistently free of symptoms, persistently affected, and with recurring symptomatology. For example, using a descriptive approach, we recently characterized patterns of depression over a 30-month period after the September 11, 2001 attacks in a population-based sample of New York City (NYC) metropolitan area residents. We found that 68% of participants did not meet criteria for depression in the 30 months after the September 11, 2001 attacks, whereas 30% experienced at least one episode of depression, and 2% were persistently depressed (15). These results are consistent with theoretical frameworks proposing that exposure to traumatic events may result in distinct trajectories of depressive symptoms ranging from an absence of symptoms to chronically severe levels of dysfunction (16).

A number of factors may predict membership in distinct trajectory subgroups following exposure to a disaster. Individuals with a history of traumatic event exposure or who have comorbid psychiatric conditions may experience greater

From the Center for Population and Development Studies; Harvard School of Public Health; Boston, MA (A.N.); Department of Epidemiology, University of Michigan School of Public Health (M.T., S.G.) and Survey Research Center, Institute for Social Research (S.G.), Ann Arbor, MI; Center for Urban Epidemiologic Studies, New York Academy of Medicine (J.R.B., D.V., S.G.) and Department of Epidemiology, Columbia University Mailman School of Public Health (D.V., S.G.), New York, NY; School of Public Health, University of Sydney; Sydney (J.R.B.) and Faculty of Health and Applied Science, Southern Cross University, Lismore (J.R.B.), NSW, Australia.

Address correspondence to: Sandro Galea, MD, DrPH, Professor, Department of Epidemiology, University of Michigan, School of Public Health, 109 Observatory St, Room 3663, Ann Arbor, MI 48109-2029. Tel: (734) 647-9741. fax: (734) 763-5706. E-mail: sgalea@umich.edu.

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Selected Abbreviations and Acronyms

BSI = Brief Symptom Inventory
DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition.
NYC = New York City
SCID = Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, Third Edition Revised

depressive disruption over time (3). Peri-event characteristics, including a greater degree of exposure to a disaster event, may be associated with a more chronic course of psychopathology (3, 9, 10). Additionally, the post-disaster environment may be important; ongoing exposure to stressful or traumatic events or, alternatively, having less access to social supports or other salutary resources, may predict membership in more symptomatic trajectories (9, 15).

There is growing evidence for heterogeneity in the longitudinal patterns of depression in population-based studies (17). However, analyses in populations exposed to mass traumatic events have generally treated depression as a homogeneous outcome characterized by a common longitudinal course of symptoms and we are not aware of any work that has applied emerging statistical methods, such as latent growth modeling, to identify trajectories of depression in the aftermath of a disaster. In contrast to conventional growth modeling approaches, latent growth modeling approaches assign specific growth parameters to unobserved population subgroups with relatively homogeneous developmental paths (18, 19). This makes it possible to test whether distinct longitudinal trajectories of depression are present in a population and, relative to subjective classification strategies, avoids the identification of spurious clusters that may reflect random variation rather than true heterogeneity in longitudinal trajectories (20).

In this study, we extend our prior work (15) by using a latent class growth analysis to examine trajectories of depression, as well the time-fixed and time-varying determinants of distinct depressive trajectories, among a representative sample of adult residents of the NYC metropolitan area after the September 11, 2001 terrorist attacks.

METHODS

Participants

We conducted a random-digit-dial household survey to recruit baseline respondents approximately 6 months after the September 11 attacks (March 25–June 25, 2002). The sampling frame consisted of all adults (18 years of age and older) in the NYC metropolitan area. Interviews were conducted in English, Spanish, Mandarin, and Cantonese by trained interviewers using translated and back-translated

questionnaires and a computer-assisted telephone interview system. Households were screened for eligibility by location. If eligible, an adult in each household was randomly selected by choosing the adult whose birthday was closest to the interview date. Up to 10 attempts were made to conduct the interview. Further details on this study are provided elsewhere (21).

Contact information was obtained for respondents, their key family members, and other important contacts. Three follow-up interviews were conducted approximately 6, 18, and 30 months after baseline (September 25, 2002–January 31, 2003; September 25, 2003–February 29, 2004; December 15, 2004–November 30, 2005). The mean interview time for all surveys was approximately 35 minutes. The Institutional Review Board at the New York Academy of Medicine approved the study and all study subjects provided oral consent at the time of the interview.

Measures

We used a modified version of the Structured Clinical Interview for *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition Revised (SCID) (22), a validated approach that captures symptoms of major depression consistent with *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (DSM-IV) criteria (23), to assess symptoms of major depression. Respondents were asked about the presence for over 2 weeks of any of 10 symptoms of depression representing criterion A for major depression in DSM-IV. At the baseline interview, respondents who reported two or more symptoms that occurred together in a 1-month period were asked about the timing of their most recent symptoms; symptoms were categorized as having occurred before or since the September 11 attacks. The timing of symptoms for respondents who reported either one symptom of depression or two or more symptoms of depression that did not occur together in a 1-month period was unavailable, and these symptoms were categorized as having occurred before the September 11, 2001 attacks. Consistent with DSM-IV guidelines, lifetime depression at baseline was defined as having five or more symptoms for at least 2 weeks at any time in the past. At subsequent follow-up interviews, we asked about the number of symptoms experienced for at least 2 weeks since the prior interview.

The Cronbach alpha for 10 items used in our depression scale was 0.79 (24). Furthermore, in a prior validation study comparing our instrument, with depression defined dichotomously as five symptoms experienced for at least 2 weeks, with the Brief Symptom Inventory (BSI) (25), the BSI depression scale had a sensitivity of 73% and specificity of 87% as classified by our instrument (26). In addition to being used in previous surveys focusing on the effects of the September 11 attacks, this scale has also been used in other population surveys (5, 27).

Time-fixed covariates were assessed at baseline. We asked about sociodemographic factors, including age, gender, race/ethnicity, marital status, and educational attainment. To evaluate pre-event stressors, we asked respondents if they experienced divorce or separation, marriage, family problems, problems at work, or unemployment in their lifetime prior to the September 11 attacks. We asked about exposure to any of 12 traumatic events (e.g., natural disaster; accident at work, in a car, or somewhere else; assault with a weapon; unwanted sexual contact; death of a spouse or mate) in the time prior to the September 11 attacks. To assess whether respondents were directly affected by the September 11 attacks, we asked if they were in the World Trade Center on September 11, injured during the attacks, had a friend or relative killed, had possessions lost or damaged, lost a job because of the attacks, or were involved in the rescue effort. In the analysis, exposure to pre-event stressors, exposure to pre-event traumatic events, and direct exposure to the September 11 attacks were dichotomized. To evaluate social support we asked about emotional (e.g., “someone to love you and make you feel wanted”), instrumental (e.g., “someone to help you if you were confined to bed”), and appraisal (e.g., “someone to give you good advice in a crisis”) support in the 6 months prior to the September 11 attacks using an abbreviated version of the Medical Outcomes Study social support scale (28). The Cronbach alpha for the five-item modified version of this scale was 0.90 (29). For the analysis, social support scores were summed and categorized as low, medium, or high based on the tertiles of social support reported in the sample. To assess peri-event emotional reactions to the September 11 attacks, we used a modified version of the Diagnostic Interview Schedule subscale for panic attack (30), phrased to detect symptoms experienced “in the first few hours” after the September 11 terrorist attacks. Respondents who reported at least four out of a total of 16 symptoms were classified as having had a peri-event emotional reaction. Further information on the measurement of peri-event emotional reactions is provided elsewhere (31).

Time-varying covariates, including household income, stressors, and traumatic events, were assessed at each interview. Ongoing stressors and traumatic events were measured using the same items as time-fixed stressors and traumatic events, as described above. At baseline, respondents reported their experience of stressors and traumatic events since the September 11 attacks; in follow-up interviews, respondents reported their experience of stressors and traumatic events since the prior interview. Time-varying variables for ongoing stressful and traumatic events were dichotomized for analysis into those who did or did not experience any stressors or traumatic events at each time point. Household income was updated at each interview

and was dichotomized as less than \$30,000 or greater than or equal to \$30,000 for this analysis.

Statistical Analyses

Sampling weights were developed and applied to the data to correct for potential selection bias relating to the number of household telephones, persons in the household, and over-sampling. We also applied post-stratification weights to make the follow-up survey samples demographically representative of the NYC metropolitan area population according to the 2000 U.S. census (32).

We used semi-parametric group-based modeling, a type of latent growth curve analysis, to identify trajectories of depressive symptoms across survey waves and to assess determinants of trajectory group membership (20, 33). We fit zero-inflated Poisson regression models to account for the greater number of zeros in the count of depressive symptoms than would be expected under the Poisson distribution. The Bayesian Information Criterion was used to select the best-fitting model. After selecting the model with the optimal number of trajectory groups, we determined the appropriate shape of each trajectory group (i.e., linear, quadratic, cubic) based on statistical significance ($p < 0.05$). For each individual, we calculated the probability of belonging to each trajectory group. Individuals were then assigned to the group with the largest posterior probability. Adjusted analyses were conducted by contemporaneously adding time-fixed and time-varying covariates to the best-fitting trajectory models; time-fixed covariates were added assuming they affected the probability of group membership and time-varying covariates were added assuming they affected the expected number of depressive symptoms within each trajectory group. Only variables that were significantly associated with trajectory group membership in bivariate models were considered in adjusted models.

RESULTS

Sample Characteristics

Of the 2,752 total baseline participants, 2,282 completed at least one follow-up interview and were included in the study sample. The respondents included were comparable to both the total baseline sample and the general population of the NYC metropolitan area with respect to basic demographic characteristics (15). The distributions of time-fixed and time-varying covariates for the baseline and three follow-up waves are shown in Table 1. At baseline, the mean age was 44.7 years, 45.2% of respondents were male, 60.0% were married, 64.5% had at least some college education, and the racial/ethnic composition was 55.5% white, 5.4% Asian, 16.6% black, 18.5% Hispanic, and 4.1% other race/ethnicity. Of baseline respondents, 20.6% reported at

TABLE 1. Distributions of time-fixed covariates, time-varying covariates, and depressive symptoms across study waves among residents of the NYC metropolitan area aft the September 11, 2001 attacks ($N = 2,282$)

	Wave 1		Wave 2		Wave 3		Wave 4	
	No.	Weighted %	No.	Weighted %	No.	Weighted %	No.	Weighted %
<i>Time-fixed covariates</i>								
Total	2282		1939		1832		1610	
Age								
18-24	202	12.98	164	13.72	142	13.64	128	13.72
25-34	503	21.42	389	23.90	356	23.89	311	23.84
35-44	499	20.97	424	20.61	420	20.63	339	20.81
45-54	450	19.76	398	18.96	377	19.00	343	19.01
55-64	299	13.24	266	12.24	252	12.23	237	12.20
≥65	307	11.63	277	10.57	269	10.61	236	10.63
Gender								
Male	1034	45.19	869	45.75	807	45.71	723	45.74
Female	1248	54.81	1070	54.25	1025	54.29	887	54.26
Race/ethnicity								
White	1363	55.50	1188	53.11	1130	53.18	1017	53.15
Asian	129	5.35	94	5.38	100	5.36	80	5.36
Black	317	16.60	265	16.73	248	16.68	209	16.69
Latino	364	18.49	293	20.63	269	20.62	226	20.63
Other	75	4.06	67	4.16	58	4.17	53	4.16
Marital status								
Married	986	50.95	845	49.72	821	51.72	719	51.31
Divorced/Separated/Widowed	471	16.30	411	15.53	389	14.54	334	14.06
Single/Unmarried couple	816	32.75	675	34.75	614	33.73	553	34.63
Education								
Graduate work/College degree	1139	42.48	987	43.16	930	43.48	837	44.20
Some college	434	21.99	364	21.67	357	22.48	315	23.03
High school	481	25.57	405	24.97	385	25.38	328	24.18
Less than high school	219	9.96	176	10.19	156	8.66	123	8.59
Pre-September 11 stressors								
0	1785	79.43	1527	79.91	1444	79.79	1281	80.28
≥1	497	20.57	412	20.09	388	20.21	329	19.72
Pre-September 11 traumatic events								
0	530	23.23	425	22.68	423	23.68	372	23.73
1-2	990	45.08	857	44.90	803	45.84	694	45.64
≥3	762	31.69	657	32.42	606	30.48	544	30.63
Directly affected by September 11^d								
No	1622	71.96	1383	71.93	1294	71.65	1137	70.86
Yes	660	28.04	556	28.07	538	28.35	473	29.14
Social support								
High	882	39.12	756	39.29	700	39.08	638	40.65
Medium	663	31.12	565	31.24	542	30.85	470	30.38
Low	702	29.76	589	29.47	561	30.07	480	28.97
Peri-event emotional reaction								
No	1949	86.29	1657	86.71	1564	86.30	1380	86.07
Yes	339	13.71	282	13.29	268	13.70	230	13.93
Lifetime depression								
No								
Yes	543	19.92	467	20.40	445	19.71	405	21.34
<i>Time-varying covariates</i>								
Low household income								
≥\$30,000	1368	72.09	1131	68.55	1119	71.72	1027	71.35
<\$30,000	537	27.91	504	31.45	474	28.28	418	28.65
Ongoing stressors								
0	2054	90.95	1337	69.26	1227	66.55	1053	66.04
≥1	228	9.05	602	30.74	605	33.45	557	33.96
Ongoing traumas								
0	1956	86.14	1330	67.30	1025	55.25	846	54.00
≥1	326	13.86	609	32.70	807	44.75	764	46.00
Depressive symptoms, mean (SE)	0.82 (2.22)		1.85 (2.58)		1.98 (2.67)		2.11 (2.78)	

NYC = New York City; SE = standard error (of the mean).

least one pre-September 11th stressor and 9.1% experienced at least one ongoing stressor between the September 11th attacks and their baseline interview. At least one pre-September traumatic event and ongoing traumatic event were reported by 76.8% and 13.9% of respondents, respectively. Twenty-eight percent of respondents were directly affected by the attacks and 13.7% experienced a peri-event emotional reaction. At baseline, 27.9% of respondents reported less than \$30,000 in household income. The mean numbers of depressive symptoms were 0.82, 1.85, 1.98, and 2.11 at waves 1, 2, 3, and 4, respectively.

Trajectories of Depressive Symptoms

Using the Bayesian information criterion to compare models with different numbers of trajectory groups, we found that a model with five groups provided the best fit for the patterns of depressive symptoms in our sample. As shown in Table 2, the depressive symptom growth curves for groups 1 and 5 were best defined by intercept, linear, and quadratic terms, whereas parameter estimates for groups 2, 3, and 4 suggested cubic trends. The average posterior probabilities of group assignment ranged from 0.733 to 0.924 for the trajectory groups. Growth curves for the five groups are shown in Fig. 1. Three groups were described by the absence of depressive symptomatology at baseline, but were distinguished by distinct increases in the number of symptoms over the study period. On average, respondents in group 1 (39.4% of the sample) gradually increased to fewer than one symptom of depression over the course of follow-up. In the 6 months after baseline, respondents in groups 2 and 4 showed average increases of 1.5 and 5 depressive symptoms, respectively. Thereafter, respondents in group 2 (33.5% of the sample) increased to two symptoms at the end of the study period, whereas the number of depressive symptoms among respondents in group 4 (13.2% of the sample) increased by approximately one symptom between 6 and 18 months after baseline and then decreased gradually until the end of the study period. Two groups were characterized by depressive symptomatology at baseline. On average, respondents in group 3 (5.6% of the sample) showed a decrease from approximately five depressive symptoms to one symptom in the 6 months after baseline, followed by a gradual decline in symptomatology until the end of the study period. Group 5 (8.3% of the sample) declined from approximately seven to five and a half depressive symptoms in the first 6 months after baseline and then showed an average increase to six symptoms at the end of the study period.

Determinants of Depressive Trajectory Groups

The results of a fully adjusted model assessing the relation between time-fixed and time-varying covariates and membership in depressive symptom trajectory groups are

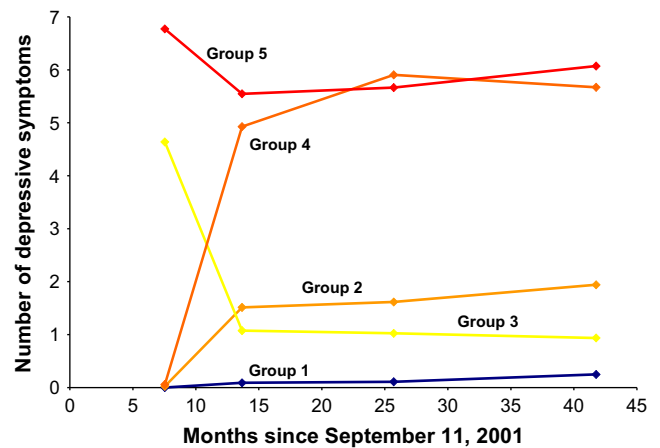


FIGURE 1. Trajectories of depressive symptoms among residents of the NYC metropolitan area after the September 11, 2001 attacks (N = 2,282).

presented in Table 3. Women were more likely than men to have been assigned to group 4 relative to group 1, the group that showed minimal symptomatology over time. Black or Latino race/ethnicity, compared to white, was associated with membership in groups 2, 4, and 5 relative to group 1. Relative to married respondents, single respondents were more likely to be in groups 2, 4, and 5 relative to group 1, whereas divorced, separated, or widowed respondents were less likely to be in group 3 relative to group 1. Relative to respondents with at least a college degree, those with lower educational attainment were more likely to be assigned to groups 2, 4, and 5 and less likely to be assigned to the group 3 compared to group 1. Exposure to at least one pre-September 11 stressor compared to none was associated with membership in groups 4 and 5 compared to group 1. Exposure to at least three pre-September 11 traumatic events compared to none was associated with membership in groups 3 and 4 relative to the group 1. Those who were directly affected by the September 11th attacks were more likely than those who were not to be assigned to group 3 relative to the group 1. Participants with low to medium levels of social support compared to higher levels were more likely to be assigned to groups 4 and 5 relative to group 1. Those who experienced a peri-event emotional reaction were more likely than those who did not to be in group 5 relative to group 1. Those who reported lifetime depression prior to the attacks were more likely than those who did not to be assigned to groups 3, 4, and 5 relative to group 1.

Among time-varying covariates, we found that lower household income relative to higher income was associated with an increased number of depressive symptoms for members of group 4. Reporting one or more ongoing stressors relative to none was associated with an increased number of depressive symptoms for members of groups

TABLE 2. Parameter estimates, prevalence, and mean posterior probability of assignment for each trajectory group of depressive symptoms among residents of the NYC metropolitan area after the September 11, 2001 attacks (2,282)

	Parameter	Estimate (SE)	p Value	Mean posterior probability (SD)	Prevalence
Group 1	Intercept	-5.084 (0.570)	<0.001	0.733 (0.242)	39.4
	Linear	0.160 (0.036)	<0.001	—	—
	Quadratic	-0.002 (0.001)	0.003	—	—
Group 2	Intercept	-7.302 (0.657)	<0.001	0.889 (0.135)	33.5
	Linear	0.964 (0.102)	<0.001	—	—
	Quadratic	-0.036 (0.004)	<0.001	—	—
	Cubic	0.0004 (0.0001)	<0.001	—	—
Group 3	Intercept	4.772 (0.753)	<0.001	0.846 (0.196)	5.6
	Linear	-0.597 (0.152)	<0.001	—	—
	Quadratic	0.023 (0.007)	0.002	—	—
	Cubic	-0.0003 (0.0001)	0.006	—	—
Group 4	Intercept	-7.216 (0.478)	<0.001	0.924 (0.124)	13.2
	Linear	1.108 (0.077)	<0.001	—	—
	Quadratic	-0.042 (0.003)	<0.001	—	—
	Cubic	0.0005 (0.0001)	<0.001	—	—
Group 5	Intercept	2.113 (0.073)	<0.001	0.866 (0.163)	8.3
	Linear	-0.036 (0.011)	0.001	—	—
	Quadratic	0.001 (0.0002)	0.003	—	—

SE = standard error; SD = standard deviation.

2 and 4. Finally, reporting exposure to one or more ongoing traumatic events compared to none was associated with an increased number of depressive symptoms for those assigned to groups 1, 2, 4, and 5.

DISCUSSION

Trajectories of Depressive Symptoms

Our findings suggest that the epidemiology of depression after exposure to mass trauma is more adequately described by a heterogeneous set of distinct trajectory subgroups than a homogenous population-average level of symptoms over time. Using the DSM-IV, which defines depression based on the presence of five or more symptoms experienced during at least a 2-week period, as a rough guideline we can categorize distinct trajectories as clinically or not clinically relevant. We found that the most common trajectory of depression after the September 11 attacks was group 1, which was characterized by resistance, or negligible levels of depressive symptoms over time; in contrast, fewer than 10% of respondents were assigned to group 5, characterized by chronic levels of severe symptomatology. These findings corroborate the prevailing observation that most individuals exposed to mass trauma maintain a relatively stable trajectory of healthy functioning, whereas a smaller proportion are persistently depressed (15). We identified three inconstant trajectories that showed changes in depressive severity over time. Almost 50% of respondents were assigned to groups 2 and 4, which showed an increase in symptomatology that persisted at mild and severe levels, respectively. Consistent with other trauma research (11), these results

suggest that delayed depression may be a common trajectory of depression following disasters. Members of group 3 showed a monotonic decline in depressive symptoms over time that is characteristic of research assessing the longitudinal course of depression in samples anchored to a specific event, be they clinical samples or samples collected after mass traumas (27). This group was characterized by clinically relevant levels of depression at baseline; however, by the end of follow-up, levels of depressive symptoms in this group approached mild levels, suggesting that this trajectory represented recovery rather than resilience, which is described in the literature by a more rapid return to normal functioning (16).

Determinants of Depressive Trajectory Groups

Our findings suggest that trajectory groups are distinguished by a number of factors. Sociodemographic characteristics, including race/ethnicity and marital status, frequently discriminated between the trajectory groups, even after adjusting for other factors including exposure to stressors, exposure to traumatic events, and social support. For example, relative to whites, we found that blacks and Latinos were more likely to be assigned to the three trajectory groups characterized by persistent levels of depressive symptoms than the resistance group. Similarly, single compared to married status and less compared to more educational attainment were both associated with membership in groups characterized by persistent depressive symptomatology. There are a number of potential explanations for these important sociodemographic differences between groups. For example, differential access to salutary resources

TABLE 3. Adjusted model assessing the relation between time-fixed and time-varying covariates and trajectory group membership among NYC metropolitan area residents after the September 11, 2001 attacks (N = 2,282)

	Group 1		Group 2		Group 3		Group 4		Group 5	
	Estimate (SE)	p Value*	Estimate (SE)	p Value	Estimate (SE)	p Value	Estimate (SE)	p Value	Estimate (SE)	p Value
<i>Time-fixed covariates[†]</i>										
Age										
18–24	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
25–34	0.000	–	0.246 (0.649)	0.704	0.150 (0.558)	0.788	0.741 (0.572)	0.195	–0.390 (0.718)	0.587
35–44	0.000	–	0.620 (1.017)	0.542	–0.068 (0.659)	0.918	1.286 (0.626)	0.040	0.268 (0.748)	0.720
45–54	0.000	–	0.484 (0.945)	0.609	–0.119 (0.657)	0.857	1.064 (0.625)	0.089	–0.100 (0.753)	0.894
55–64	0.000	–	0.534 (0.892)	0.550	–0.257 (0.869)	0.768	0.540 (0.628)	0.390	–0.657 (0.846)	0.438
≥65	0.000	–	1.650 (0.872)	0.058	–0.423 (1.068)	0.692	1.940 (0.669)	0.004	–1.038 (1.135)	0.360
Gender										
Male	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
Female	0.000	–	0.410 (0.412)	0.320	0.531 (0.366)	0.146	1.043 (0.279)	<0.001	0.724 (0.423)	0.087
Race/ethnicity										
White	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
Asian	0.000	–	0.023 (0.900)	0.980	–0.196 (0.676)	0.772	0.092 (0.504)	0.854	–0.587 (1.184)	0.620
Black	0.000	–	1.225 (0.493)	0.013	0.440 (0.852)	0.605	1.156 (0.429)	0.007	1.186 (0.552)	0.032
Latino	0.000	–	1.314 (0.531)	0.013	0.679 (0.719)	0.345	0.932 (0.468)	0.047	1.105 (0.598)	0.065
Other	0.000	–	–0.812 (1.117)	0.467	–1.079 (1.447)	0.456	–0.171 (0.546)	0.754	–1.166 (0.850)	0.170
Marital status										
Married	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
Divorced/Separated/Widowed	0.000	–	–0.610 (0.607)	0.315	–1.404 (0.698)	0.044	0.069 (0.348)	0.843	0.684 (0.537)	0.203
Single/Unmarried couple	0.000	–	1.196 (0.587)	0.042	0.618 (0.478)	0.196	1.117 (0.378)	0.003	1.924 (0.503)	<0.001
Education										
Graduate work/College degree	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
Some college	0.000	–	0.142 (0.420)	0.735	–0.794 (0.564)	0.159	0.016 (0.326)	0.961	0.695 (0.458)	0.129
High school	0.000	–	1.011 (0.417)	0.015	0.288 (0.546)	0.598	0.973 (0.342)	0.004	1.740 (0.522)	0.001
Less than high school	0.000	–	–0.521 (1.208)	0.667	–15.593 (1.155)	<0.001	0.103 (0.774)	0.894	1.228 (0.884)	0.165
Pre-September 11 stressors										
0	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
≥1	0.000	–	0.978 (0.545)	0.073	0.764 (0.496)	0.124	1.317 (0.378)	0.001	2.056 (0.476)	<0.001
Pre-September 11 traumatic events										
0	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
1–2	0.000	–	0.449 (0.567)	0.429	–0.175 (0.583)	0.765	0.778 (0.343)	0.023	0.267 (0.578)	0.644
≥3	0.000	–	0.545	0.386	1.101 (0.527)	0.037	0.932 (0.373)	0.013	–0.023 (0.588)	0.969
Directly affected by September 11[‡]										
No	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
Yes	0.000	–	–0.075 (0.448)	0.868	0.909 (0.450)	0.043	0.037 (0.319)	0.907	0.471 (0.432)	0.276
Social support										
High	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
Medium	0.000	–	0.727 (0.485)	0.134	–0.389 (0.443)	0.380	0.696 (0.302)	0.021	0.999 (0.493)	0.043
Low	0.000	–	1.163 (0.468)	0.013	–0.773 (0.835)	0.355	1.381 (0.346)	<0.001	2.092 (0.451)	<0.001
Peri-event emotional reaction										
No	0.000	–	0.000	–	0.000	–	0.000	–	0.000	–
Yes	0.000	–	1.134 (0.656)	0.084	0.865 (0.664)	0.193	0.767 (0.533)	0.150	1.806 (0.573)	0.002

(Continued)

TABLE 3. (Continued)

	Group 1		Group 2		Group 3		Group 4		Group 5	
	Estimate (SE)	p Value*	Estimate (SE)	p Value	Estimate (SE)	p Value	Estimate (SE)	p Value	Estimate (SE)	p Value
<i>Time-varying covariates[§]</i>										
Lifetime depression										
No	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
Yes	0.000	-	0.789 (0.729)	0.279	2.696 (0.704)	<0.001	1.509 (0.502)	0.003	5.188 (0.641)	<0.001
Low household income										
≥\$30,000	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
<\$30,000	0.751 (0.315)	0.017	0.187 (0.227)	0.409	-0.278 (0.324)	0.391	0.277 (0.107)	0.010	0.101 (0.070)	0.149
Ongoing stressors										
0	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
≥1	0.373 (0.506)	0.461	1.019 (0.207)	<0.001	0.155 (0.217)	0.476	0.417 (0.116)	<0.001	-0.001 (0.074)	0.992
Ongoing traumas										
0	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
≥1	1.338 (0.316)	<0.001	0.481 (0.240)	0.045	0.348 (0.248)	0.160	0.505 (0.082)	<0.001	0.232 (0.084)	0.006

SE = standard error.
*Wald test p value.
[†]Estimates for time-fixed covariates reflect probability of group membership, with reference to Group 1 (resistance).
[‡]Respondents who were in the World Trade Center on September 11, injured during the attacks, had a friend or relative killed, had possessions lost or damaged, lost a job because of the attacks, or were involved in the rescue effort.
[§]Estimates for time-varying covariates reflect effect on the expected number of depressive symptoms within each trajectory group.

not considered in this study, including access to mental health care and stable employment, may explain differences by race/ethnicity, marital status, and education (34-36).

Respondents with greater exposure to pre-event stressors and traumatic events and fewer social supports to buffer them were more likely to be assigned to highly symptomatic versus less symptomatic depressive groups. For example, we found that the two groups with severe levels of symptoms, the chronic severe depression and severe delayed depression groups, were the only groups that were more likely to report exposure to pre-event stressors relative to the resistance group. Exposure to prior stressors may exacerbate levels of depression in the aftermath of a disaster. Furthermore, we found that respondents who experienced a peri-event emotional reaction in the first few hours after the September 11th attacks were more likely than those who did not to be assigned to the group with chronic severe depression, relative to the resistance group. Although the temporality is indeterminate, a peri-event emotional reaction may be an important predictor of persistent psychopathology following traumatic event experiences. Finally, those reporting a lifetime history of depression were more likely than respondents who did not to be assigned to groups with a higher initial number of depressive symptoms.

Among time-varying covariates, we found that lower household income and exposure to ongoing stressors and traumatic events were associated with an increased number of depressive symptoms in various trajectory groups, with the exception of the recovery group. Our findings corroborate recent work showing that decreased standards of material living were associated with increased depressive symptomatology in a general population sample (37). Post-migration stressors have also been associated with increased depression scores in a sample of refugee children (12). In disaster settings, our findings suggest that the experience of ongoing adversity may function to protract levels of depression over time. These results highlight the importance of considering ongoing stressful circumstances, as well as the material resources for adequately coping with them, to improve trajectories of depression after exposure to mass trauma.

Limitations

There are several limitations to this study. First, we used telephone interviews to assess depressive symptoms. Although it has been shown that telephone and in-person assessment of Axis I disorders, including depression, result in comparable estimates of symptomatology (38, 39), depressive symptoms collected via self-report cannot be equated to depression assessed by a trained clinician. Second, our sampling frame excluded respondents without a household telephone. However, we found that there

were no significant differences in the distribution of key demographic characteristics between the sample included in this analysis and the general population of the NYC metropolitan area, both at baseline and during subsequent follow-up waves (32). Third, it is possible that losses to follow-up may have biased our sample. However, we found that the application of censoring weights in another study using the same data set did not appreciably alter results (15), suggesting that our findings are not sensitive to the degree of loss to follow-up that occurred in our sample. Fourth, we were unable to control for medication use. However, we did adjust for lifetime depression, which was associated with membership in more symptomatic groups compared to the resistance group, suggesting that assignment to the resistance group was not an artifact of anti-depressive medication use. Fifth, in order to achieve the convergence of our statistical models, we dichotomized time-varying covariates. This may have introduced measurement error. Finally, because of data limitations, the timing of depressive symptoms was categorized as having occurred before the September 11, 2001 attacks for respondents who reported one symptom or two or more symptoms that did not occur together in a 1-month period. In separate analyses we assessed the sensitivity of our results to this assumption and found few qualitative differences in terms of either the patterns or predictors of depressive symptom trajectories in our sample.

CONCLUSIONS

We found evidence of distinct trajectories of symptoms of depression in a representative sample of adult residents of the NYC metropolitan area after the September 11 attacks. Our results suggest that the number of depressive symptoms endorsed by an individual following exposure to mass trauma may not be an appropriate prognosticator for targeted intervention. For example, at any particular occasion, cross-sectional analyses imply that individuals with the same number of depressive symptoms are categorically similar. However, our analyses suggest that individuals with the same number of depressive symptoms at any particular time may belong to clinically distinct subgroups. This underlines the importance of identifying distinct depressive trajectories rather than assuming that all persons follow a similar clinical course.

We also found that the determinants of depressive symptoms vary by trajectory group. Our analysis of the time-fixed and time-varying covariates suggested that factors including race/ethnicity, education, income, and exposure to stressors and trauma might underlie the gradient we observed in susceptibility to depression. Future work aimed at building models to predict depressive

trajectory membership among individuals exposed to trauma may facilitate targeted interventions that reduce the burden of depression after disasters.

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