

# Longitudinal Determinants of Posttraumatic Stress in a Population-Based Cohort Study

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**Background:** Posttraumatic stress disorder is a prevalent and disabling psychologic pathology. Longitudinal research on the predictors of posttraumatic stress symptomatology is limited.

**Methods:** We recruited 2752 participants to a prospective, population-based cohort study by conducting a telephone survey of adult residents of the New York City metropolitan area in 2002; participants completed 3 follow-up interviews over a 30-month period. Censoring weights were estimated to account for potential bias. We used generalized estimating equation logistic regression models with bootstrapped confidence intervals to assess the predictors of posttraumatic stress over time in multivariable models.

**Results:** Predictors of posttraumatic stress over time included ongoing stressors (odds ratio [OR] = 1.91 per 1 unit increase in number of stressors, [95% confidence interval = 1.55–2.36]) and traumatic events (OR = 1.92 per 1 unit increase in number of traumatic events [CI = 1.71–2.22]), social support (compared with high levels, OR = 1.71 for medium [1.09–2.52]; OR = 1.57 for low [1.08–2.35]), low income (OR = 0.87 per \$10,000 increase [0.81–0.92]), female sex (1.60 [1.11–2.23]), and Latino ethnicity (compared with white, OR = 1.74 [1.05–2.97]).

**Conclusions:** These findings suggest that ongoing stressors play a central role in explaining the trajectory of posttraumatic stress over time, and that factors beyond the experience of stressors and traumas may account for sex and ethnic differences in posttraumatic stress risk. Interventions that focus on reducing ongoing adversity may help mitigate the consequences of traumatic events.

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Over the past 20 years, several large studies have documented a high prevalence of posttraumatic stress disorder (PTSD) in the general population and a substantial health burden from this disorder.<sup>1–3</sup> A range of risk factors for PTSD have been identified, including genetic inheritance, childhood experiences, the experience of major adverse traumas and stressors, sociodemographic characteristics, and personality traits.<sup>4–7</sup>

However, much of the published research on PTSD in population-based samples has been cross-sectional, and among the longitudinal studies, most have been limited to 1 follow-up interview.<sup>8</sup> The available information about the development of PTSD is limited in 2 primary ways. First, we have little information about the contribution of changes in life circumstances and experiences to the risk of PTSD. Second, it is well recognized that prior history of psychopathology is an important determinant of future risk of psychopathology,<sup>9–11</sup> yet, very few assessments have accounted for previous history of psychopathology in analyses of current PTSD. With increasing concern about traumatic exposures and their psychologic consequences (including mass traumas such as natural disasters and terrorist incidents), a better understanding of the factors that are associated with PTSD over time, particularly potentially modifiable factors, becomes important. Such information may provide clues as to the etiology of PTSD and thereby guide programs to prevent the development and improve the management of this disabling disorder.

We examined the longitudinal determinants of posttraumatic stress symptomatology in a representative sample of residents of the New York City metropolitan area over a 30-month period, administering interviews to the same persons on 4 occasions.

## METHODS

### Sample

We recruited 2752 participants to a prospective, population-based cohort study by conducting a telephone survey of adult residents of the New York City metropolitan area between March 25, 2002, and June 25, 2002. The methods are described in more detail elsewhere.<sup>12</sup> This cohort was assembled to assess population mental health approximately 6

months after the September 11th terrorist attacks in 2001. The sample was selected through a simple area-probability random-digit-dial procedure. Baseline survey cooperation (56%) and response rate (34%) were within the accepted range for comparable random-digit-dial health surveys.<sup>13</sup> Up to 10 attempts were made to conduct an interview, and adults in each household were randomly selected by choosing the adult whose birthday was closest to the interview date.

Computer-assisted telephone interviews were conducted in English, Spanish, Mandarin, and Cantonese by trained interviewers using translated and back-translated questionnaires. Our first follow-up assessment, approximately 6 months after baseline (September 25, 2002, to January 31, 2003) was designed to document acute changes in population burden of posttraumatic stress after the terrorist attacks and subsequent follow-up, at approximately yearly intervals (September 25, 2003, to February 29, 2004, and December 15, 2004, to November 30, 2005), was designed to document the longer-term trajectory of posttraumatic stress in the population. Interviewers had direct access to psychiatrists and psychologists for referral if indicated or if requested by participants. After complete description of the study to participants, verbal informed consent was obtained before each study phase. All participants received a nominal \$10 incentive to participate in each survey wave and a \$5 incentive between the survey waves. The institutional review board of the New York Academy of Medicine reviewed this study.

## Measures

We measured characteristics that have, in previous work,<sup>5,7</sup> been shown to be associated with posttraumatic stress. Information on individual covariates (including age, sex, race/ethnicity, income, education, and marital status) was obtained from respondents at the baseline interview using a structured questionnaire. We assessed social support by asking about the following types of support in the 6 months prior to the September 11th attacks: emotional support (eg, "having someone to love you and make you feel wanted"), instrumental support (eg, "someone to help you if you were confined to bed"), and appraisal support (eg, "someone to give you good advice in a crisis<sup>14</sup>"). We summed the responses and divided the combined social support score into thirds for analysis.

September 11th experiences were also assessed, and respondents were classified by whether they were directly affected by the attacks of the World Trade Center (in the World Trade Center complex during the attacks, injured during the attacks, lost possessions or property, had a friend or relative killed, lost job as a result of the attacks, or involved in the rescue effort). We assessed perievent emotional reactions using a modified version of the Diagnostic Interview Schedule subscale for panic.<sup>15</sup> Participants who endorsed at least 4 of the panic symptoms listed in the Diagnostic and Statistical Manual (DSM-IV) within the first

few hours after the World Trade Center attacks were classified as having had a perievent emotional reaction.

At baseline respondents were also asked about the lifetime occurrence of any of 12 traumatic events (natural disaster; serious accident at work, in a car, or somewhere else; assault with a weapon; assault without a weapon; unwanted sexual contact; serious injury or illness; other situation involving serious injury or physical damage; situation causing fear of death or serious injury; seeing someone seriously injured or violently killed; death of a spouse or mate; death of a close family member other than a spouse; any other extraordinarily stressful situation or event). At each subsequent interview respondents were asked whether any of these 12 events had occurred since the previous interview. We also asked about stressors that may be experienced in daily life and that are not considered to be traumatic events, as listed above. These included divorce or separation, marriage, family problems, problems at work, and unemployment.<sup>16</sup> Respondents reported events for the previous year at baseline, and then at each follow-up interview they reported events since the previous interview. Each trauma or stressor was reported dichotomously by respondents, and sums of these events (sum of traumas, sum of stressors) at baseline or during the previous follow-up period were included in the analysis.

We used the National Women's Study posttraumatic stress module questions<sup>17</sup> to assess posttraumatic stress symptoms. At the baseline interview, participants were asked about lifetime occurrence of symptoms and about symptoms since the September 11th terrorist attacks; at all follow-up interviews they were asked about posttraumatic stress since the last interview. This module was validated in a field trial against the PTSD module of the Structured Clinical Interview for DSM-III-R administered by mental health professionals. In the field trial, instrument sensitivity was 99% and specificity was 79% when compared with the Structured Clinical Interview diagnosis.<sup>17</sup> Previous research using this measure among persons with a history of specific potentially traumatic events (eg, rape, physical assault, or crime more generally) has shown that associations of these covariates with posttraumatic stress were highly consistent with those reported in other epidemiologic studies that carefully assessed both history of events and posttraumatic stress, suggesting good construct validity for the module we used.<sup>18-20</sup> This module assesses the presence of criterion B (reexperiencing, eg, intrusive memories, distressing dreams), C (avoidance, eg, efforts to avoid thoughts associated with the trauma, loss of interest in significant activities), and D (arousal, eg, difficulty falling asleep or concentrating) symptoms and determines content for content-specific symptoms (eg, content of dreams or nightmares) if symptom presence is endorsed. Symptom endorsement was dichotomous (yes/no) and symptoms were assessed in relation to any trauma at any time in the respondents' lifetime, before or after September 11th. We assessed

posttraumatic stress based on the presence of at least one reexperiencing symptom, at least 3 avoidance symptoms (content-specific where relevant), and 2 arousal symptoms. Because this was a lay-administered structured interview rather than a clinical interview, no diagnosis of PTSD can be established from this data. Since its implementation, the National Women's Study posttraumatic stress scale has been used in a number of large-scale mental health surveys involving over 16,000 completed telephone interviews, and further information about scale validity is available in previously published work.<sup>18–21</sup>

## Statistical Analyses

Sampling weights were applied to the data to correct for potential selection bias relating to the number of household telephones, persons in the household, and oversampling. We compared the distributions of key demographic characteristics for respondents included in our analysis to respondents included in the baseline sample to assess any differences between those included in the analysis and those lost to follow-up. We also compared the included respondents with 2000 US Census data for the New York City metropolitan area.<sup>22</sup>

We used logistic regression models to assess bivariable and multivariable relations of participant characteristics and experiences with posttraumatic stress symptoms, and we report robust standard errors accounting for repeated measures on the same individual using a generalized estimating equation approach.<sup>23</sup> The following characteristics were measured only during the baseline assessment and as such were modeled as time-invariant: sex, race/ethnicity, educational attainment, marital status, baseline household income, social support, lifetime traumatic events (prior to September 11, 2001), baseline traumatic events (between September 11, 2001, and the baseline interview), baseline stressors, and lifetime history of posttraumatic stress. The following variables were measured at all time points and were modeled as time-varying covariates: change in household income, traumatic events and stressors since the previous interview, and posttraumatic stress at the previous time period.

Although data were rarely missing for key variables, income was missing for approximately 18% of participants. We conducted the analyses presented here (a) restricted to persons on whom we had complete data, including income data, (b) using an indicator variable for missing income data, and (c) with missing income values imputed based on baseline demographic characteristics. To impute income, we regressed baseline income on baseline age, sex, race/ethnicity, marital status, education, and stressful life events using a linear model. For individuals missing income, baseline income values were predicted based on their baseline covariates and the model coefficients. Model results were similar regardless of how missing income was incorporated; we summarize here the multivariable analyses with income imputed based on demographic variables.

Participants with posttraumatic stress symptoms at baseline were not questioned about their lifetime history of such symptoms prior to September 11, 2001. We conducted sensitivity analyses to assess the implications of modeling these participants as having a history of posttraumatic stress and as having no such history prior to this date. Results from these models did not change appreciably, and we present here the most conservative models, in which participants with symptoms at baseline are modeled as also having prior lifetime posttraumatic stress. We also examined effect modification for plausible interactions based on the available literature, using interaction terms.

Over the course of follow-up, 46% of individuals completed all 4 interviews. Among those who missed interviews, 21% missed 1 interview, 16% missed 2, and 17% missed 3. To account for the potential effects of censored observations on our results, we estimated and applied censoring weights to the models using the so-called inverse-probability-of-censoring weighted approach to account for possible nonrandom missingness.<sup>24</sup> First, the probability of being present at each follow-up interview, based on baseline covariates (age, sex, race/ethnicity, marital status, education, income, traumatic events, stressors, social support, and exposure to the September 11 attacks), was modeled in separate logistic regression models. The predicted probability of being interviewed at each follow-up was estimated from the model for each individual, and its inverse was used as a censoring weight [ $\delta/P(\text{interview} = 1 \mid \text{baseline covariates})$ ], where  $\delta = 1$  if interviewed, 0 otherwise. Thus, individuals who had characteristics that appear to have made them likely to have been censored (unlikely to have been interviewed) at a given follow-up interview (based on their baseline characteristics) were up-weighted for that interview, while conversely individuals who had characteristics of subjects who were unlikely to have been censored (likely to have been interviewed) were down-weighted for that interview. This approach estimates the results one would have had in the absence of censoring, assuming that censoring is at random (uninformative) within groups specified by the baseline covariates (ie, there are no unmeasured or unspecified variables that predict censoring).

The true probability of censoring for each individual at each visit is unknown, and thus is estimated from a model as described above. Once an estimated weight has been incorporated into a regression model, confidence intervals (CIs) must be bootstrapped because no analytical estimate of the standard errors is available. Both the estimation of the censoring weights and the final model applying those weights were bootstrapped in this analysis. For consistency across the final models, all CIs were bootstrapped even when censoring weights were not used. All analyses were carried out using SAS (SAS Institute, Cary, NC) and SUDAAN (RTI International, Research Triangle Park, NC).

**TABLE 1.** Comparison of Full Baseline Samples, Sample Included and Excluded in the Analysis, and Data From the 2000 US Census for the New York City Metropolitan Area<sup>22</sup>

Characteristics	Full Baseline Sample (n = 2752) %	Included Sample (n = 2282) %	Excluded Sample (n = 470) %	All Person-Visits Censoring-Weighted Sample (n = 5381) %	US Census %
Age (yrs)					
18–24	13.7	13.0	17.0	13.6	11.7
25–34	24.1	21.4	35.8	24.6	20.4
35–44	20.5	21.0	18.5	20.4	21.9
45–54	18.9	19.8	15.3	18.9	17.7
55–64	12.2	13.2	7.6	12.1	11.8
≥65	10.5	11.6	5.8	10.5	16.5
Sex					
Male	46.1	45.2	49.9	46.1	46.9
Female	53.9	54.8	50.1	53.9	53.1
Race					
White	53.2	55.5	43.1	53.6	54.8
Asian	5.4	5.3	5.4	5.5	7.7
Black	16.7	16.6	17.1	16.0	16.5
Hispanic	20.6	18.5	29.8	21.1	18.5
Other	4.2	4.1	4.6	3.8	2.6
Baseline posttraumatic stress in the 6 mo since September 11, 2001					
No	91.8	91.9	91.6	92.0	
Yes	8.2	8.1	8.4	8.0	
Lifetime					
No	85.1	85.0	85.4	85.2	
Yes	14.9	15.0	14.6	14.8	

## RESULTS

Overall, 2282 (83%) respondents were interviewed at baseline and at least one follow-up interview; we have necessarily limited the sample to these participants to conduct a longitudinal analysis. There were no major differences in the distribution of demographic characteristics between the sample included in this analysis and the general population of the New York City metropolitan area based on the 2000 Census (Table 1). Although those excluded for not participating in any follow-up interviews differed from those included, accounted for these differences by our application of censoring weights.

Across the 3 measurement time intervals, the prevalences of posttraumatic stress symptoms were similar: 2.1% at the first follow-up interview, 13.6% at the second follow-up interview, and 14.3% at the third follow-up interview. Longitudinal associations between exposures of interest and posttraumatic stress are presented in Table 2, including the bivariable associations and multivariable models before and after the addition of censoring weights. In the multivariable model with censoring weights, the variables that were associated with posttraumatic stress were female sex (odds ratio [OR] = 1.60, 95% CI = 1.11–2.23), Asian ethnicity (compared with white, 0.37 [0.02–0.86]), Latino ethnicity (com-

pared with white, 1.74 [1.05–2.97]), low baseline income (OR = 0.87 per ten-thousand-dollar increase; CI = 0.81–0.92), baseline stressors (1.22 per 1 unit increase in number of stressors; 1.00–1.49), incident stressors over follow-up (1.91 per 1 unit increase in number of stressors; 1.55–2.36), baseline traumatic events (1.09 per 1 unit increase in number of traumas; 1.00–1.18), traumatic events over follow-up (1.92 per 1 unit increase in number of traumas; 1.71–2.22), lower social support (compared with high social support, medium social support OR = 1.71 [CI = 1.09–2.52], and low social support OR = 1.57 [1.08–2.35]), having a perievent emotional reaction after the September 11th attacks (1.64; 1.07–2.46), previous visit PTSD (4.37; 2.36–6.80), and lifetime PTSD (2.09; 1.48–3.53). There were no significant interactions detected.

We compared the regression parameters from the full multivariable model that included censoring weights to the model that did not include censoring weights. There were few appreciable differences in the regression parameters between the models, suggesting relatively minimal bias due to missed follow-up interviews. The main appreciable difference was the increase in the association between female sex and posttraumatic stress after accounting for censoring (OR = 1.39 without censoring weights; OR = 1.60 with censoring

**TABLE 2.** Multivariable Generalized Estimating Equation Models Predicting Posttraumatic Stress at Each Time Point

Parameter	Bivariable Associations OR (95% CI)	Multivariable Model OR (95% CI)	Multivariable Model With Censoring Weights Applied and Bootstrapped Confidence Intervals OR (95% CI)
Follow-up period			
Follow-up 1	—	—	—
Follow-up 2	1.17 (0.99–1.39)	0.90 (0.63–1.28)	0.89 (0.66–1.28)
Follow-up 3	1.22 (1.02–1.46)	0.84 (0.57–1.19)	0.88 (0.61–1.28)
Age (yrs)			
18–24	—	—	—
25–34	0.67 (0.37–1.19)	0.73 (0.40–1.49)	0.78 (0.41–1.52)
35–44	0.69 (0.39–1.21)	0.95 (0.54–1.92)	0.90 (0.48–1.84)
45–54	0.74 (0.42–1.30)	1.56 (0.87–3.12)	1.53 (0.81–3.13)
55–64	0.71 (0.38–1.29)	1.47 (0.82–2.85)	1.36 (0.71–2.86)
≥65	0.48 (0.26–0.92)	0.90 (0.38–2.01)	0.87 (0.36–2.07)
Sex			
Male	—	—	—
Female	1.70 (1.27–2.29)	1.39 (0.98–1.98)	1.60 (1.11–2.23)
Race/ethnicity			
White	—	—	—
Asian	0.33 (0.10–1.14)	0.40 (0.02–0.94)	0.37 (0.02–0.86)
Black	2.35 (1.66–3.33)	1.31 (0.88–1.98)	1.28 (0.83–1.88)
Latino	2.86 (1.93–4.22)	1.77 (1.05–2.89)	1.74 (1.05–2.97)
Other	1.95 (1.07–3.55)	0.70 (0.35–1.39)	0.69 (0.34–1.36)
Marital status			
Married	—	—	—
Divorced	2.24 (1.47–3.42)	0.60 (0.33–1.10)	0.59 (0.32–1.09)
Separated	3.40 (1.61–7.17)	1.04 (0.33–2.52)	1.36 (0.42–3.24)
Widowed	2.34 (1.42–3.86)	1.64 (0.93–3.08)	1.60 (0.92–3.00)
Single	1.82 (1.28–2.59)	1.21 (0.83–1.83)	1.12 (0.75–1.71)
Unmarried couple	3.51 (1.51–8.17)	1.30 (0.40–3.18)	1.28 (0.38–3.43)
Education			
Graduate work	—	—	—
College degree	1.99 (1.15–3.45)	1.58 (0.93–3.06)	1.55 (0.91–3.07)
Some college	2.25 (1.31–3.86)	1.06 (0.59–2.02)	1.03 (0.58–2.15)
High school	2.53 (1.47–4.36)	1.09 (0.62–2.12)	1.07 (0.58–2.07)
Less than high school	4.68 (2.56–8.57)	1.72 (0.85–3.78)	1.91 (0.92–4.47)
Income			
Baseline income	0.81 (0.78–0.85)	0.86 (0.81–0.91)	0.87 (0.81–0.92)
Ongoing change in income	0.91 (0.86–0.97)	0.94 (0.86–1.01)	0.94 (0.86–1.02)
Stressors			
Baseline stressors	1.68 (1.42–1.99)	1.21 (0.98–1.51)	1.22 (1.00–1.49)
Ongoing stressors	1.84 (1.60–2.12)	1.92 (1.56–2.35)	1.91 (1.55–2.36)
Traumatic events			
Baseline traumatic events	1.19 (1.12–1.26)	1.08 (1.00–1.17)	1.09 (1.00–1.18)
Ongoing traumatic events	1.66 (1.51–1.82)	1.87 (1.66–2.17)	1.92 (1.71–2.22)
Social support			
High social support	—	—	—
Med social support	2.09 (1.41–3.11)	1.61 (1.08–2.37)	1.71 (1.09–2.52)
Low social support	2.53 (1.75–3.65)	1.46 (0.97–2.11)	1.57 (1.08–2.35)
September 11 experiences			
Directly affected	1.40 (1.02–1.92)	1.14 (0.80–1.63)	1.07 (0.75–1.59)
Emotional reaction	4.69 (3.37–6.54)	1.96 (1.28–3.05)	1.64 (1.07–2.46)
Previous posttraumatic stress			
Since previous interview	14.06 (10.55–18.73)	3.74 (2.00–5.50)	4.37 (2.36–6.80)
Lifetime	8.21 (6.05–11.14)	2.42 (1.67–4.04)	2.09 (1.48–3.53)

weights). Other differences in magnitude include the effect of a post-September 11th emotional reaction, which was smaller after accounting for censoring (OR = 1.96 without censoring weights; OR = 1.64 with censoring weights); the effect of previous-visit posttraumatic stress, which was larger after accounting for censoring (OR = 3.74 without censoring weights; OR = 4.37 with censoring weights); and the effect of lifetime posttraumatic stress, which was smaller after accounting for censoring (OR = 2.42 without censoring weights; OR = 2.09 with censoring weights).

## DISCUSSION

This study is one of only a few to examine the longitudinal course of posttraumatic stress symptoms over multiple time points in a large population-based cohort. This longitudinal approach allowed our assessment of the influence of ongoing traumas and stressors on the risk of such symptoms over the course of follow-up, in addition to the influence of baseline exposures and sociodemographic covariates. We were able to adjust for symptoms in the previous interval (at every time point) and during the lifecourse, isolating the effect of exposures independent of prior psychopathology. Stressors and traumatic events were both associated with risk of posttraumatic stress over time in multivariable models, adjusting for other known risk factors. While the relation between ongoing experience of traumatic events and risk of posttraumatic stress symptoms is not surprising,<sup>25,26</sup> we also found that life stressors that would not typically be classified as “traumatic events” are strongly associated with such symptoms, independent of ongoing traumas.<sup>27</sup> The prominent role of ongoing stressful life events (including financial and interpersonal stressors) on the risk of posttraumatic stress over time suggests that stressful circumstances such as those that may be brought about by terrorist acts, which are specifically designed to incite fear and economic instability, may have an influence on long-term greater population risk of posttraumatic stress, distinct from the immediate impact of the traumatic event itself.<sup>28,29</sup>

We also showed that low income was a determinant of posttraumatic stress risk over time. This may further reinforce the central import of underlying economic vulnerability as a determinant of risk. Although in our final models there was no substantial association for income loss during the follow-up period, this finding was in models that already took into account self-reported financial stressors. It is likely that income changes were also reported as financial stressors by respondents, explaining the absence of an association between changes in income and posttraumatic stress risk.

This study confirmed the associations of sex and ethnicity with PTSD found in previous research. Several cross-sectional studies and longitudinal studies with shorter follow-up periods have shown that women have a greater risk of PTSD than men<sup>1,2,30</sup> and that Latinos are at greater risk of

PTSD than other racial/ethnic groups.<sup>31–33</sup> We confirmed these elevated risks for current posttraumatic stress, independent of lifetime history of posttraumatic stress, symptoms since the last interview, ongoing traumatic event experiences, and stressful life circumstances. This is a robust demonstration of the important role of female sex and Latino ethnicity in relation to posttraumatic stress over time, and our results suggest that some of the previously hypothesized explanations may not fully explain this observation. For example, it has been hypothesized that socioeconomic disadvantage and ongoing adversity both may explain these elevated risks.<sup>13,34</sup> However, here we show a persistent greater risk among women and Latinos when accounting for several measures of adversity that themselves were important predictors of risk. It is possible that our assessment of adverse circumstances does not fully capture the adversity faced by these groups. It is also possible, however, that there are other explanations, including greater vulnerability to stress among women<sup>35</sup> or differences in experience of psychologic symptoms among ethnic/racial groups,<sup>36</sup> that may account for the greater risk of posttraumatic stress in these groups. Future work should consider more precise specification of the ethnic groupings considered here to understand the pathways linking ethnic origins and risk of these symptoms.

This work highlights the role of social support as a determinant of posttraumatic stress. Several studies have shown that persons with low social support are at greater risk after any number of adverse traumatic experiences.<sup>37,38</sup> The importance of social support in shaping posttraumatic stress even when taking into account ongoing adversity suggests a potentially powerful role of informal social resources, potentially including both material and emotional supports, in mitigating the psychologic consequences of traumatic event experiences.

The importance of informal social supports, ongoing traumas, and life stressors as predictors of posttraumatic stress in our analysis may encourage practical assistance to mitigate the psychologic consequences of traumatic event experiences. Such assistance may be important both in the aftermath of individually-experienced traumatic events, such as assaults, and after collectively-experienced traumatic events, such as disasters. In the former context, several authors have advocated more practical assistance and supportive care<sup>39</sup>; in the latter context, the role of psychologic first aid (essentially supportive care and assistance with stressful postdisaster circumstances) is emerging as a key response to collective traumas.<sup>40,41</sup> There has been much debate in the peer-reviewed and popular literature about the potential role of rapid psychologic interventions after the experience of traumatic events.<sup>42</sup> While our results do not directly contribute to that debate, this work together with other work in the field provides support for the notion that practical assistance may reduce the risk of posttraumatic stress.

Because this cohort was assembled in the aftermath of a particular terrorist attack, we considered in this analysis the potential impact of exposure to that terrorist event. Although we have previously shown that exposure to the terrorist attacks of September 11th was a critical determinant of the onset of posttraumatic stress in the short-term,<sup>21,43</sup> we found that exposure to these attacks was not an important predictor of risk in the longer-term. Therefore, in the aftermath of a mass traumatic event, the recovery environment and stressors subsequent to the primary disaster are mainly what shape patterns of posttraumatic stress in the long-term.<sup>44</sup> This suggests a changing profile of persons who are at risk for posttraumatic stress in the short- and long-term after a mass traumatic event.<sup>28</sup> This poses considerable challenges for service provision and for targeted screening programs. However, it also suggests that interventions aimed at minimizing ongoing stressors in the postdisaster recovery phase, such as restoration of housing and of employment opportunities, have the potential to minimize the long-term psychologic consequences of such events.

In contrast to the fading role of the disaster event experiences themselves as determinants of posttraumatic stress over time, experiencing an emotional reaction at the time of the September 11th terrorist attacks remained a strong predictor of posttraumatic stress over time, comparable to its role as a determinant of posttraumatic stress soon after the disaster, as documented in our previous work.<sup>21,43</sup> The importance of perievent emotional reactions, both in the short-term and in the long-term, suggests an important avenue for screening persons who may be at high risk of psychopathology after a disaster, and may suggest avenues for intervention.<sup>45,46</sup> We did not have assessments of perievent emotional reactions surrounding other traumatic event experiences. Further research might fruitfully consider the prognostic role of perievent emotional reactions as a determinant of subsequent posttraumatic stress.

There are several considerations important for interpretation of this study. First, we used telephone interviews to assess symptoms of posttraumatic stress. Although it has been shown that telephone and in-person assessment of DSM Axis I disorders, including anxiety disorders and affective disorders, result in comparable estimates of symptomatology,<sup>47</sup> posttraumatic stress assessed in this manner cannot be equated to a diagnosis of PTSD. Thus, comparisons between the results of this study and other work that uses clinical assessments of psychopathology should be made cautiously. Longitudinal work involving clinician-administered interviews is necessary to confirm or refute our observations. Second, prospective studies with more frequent assessments than those employed here would be necessary to ascertain persistence of symptoms within more precise timeframes.

Third, it is possible that the persons recruited in the original sample represent a group of persons who are systematically different from the general population. Participation rates in epidemiologic studies are always a concern with

respect to bias that may result from differential self-selection. In the context of assessments of large and disparate geographic areas such as in this study, where the organization of representative in-person surveys would be logistically challenging and prohibitively expensive, the best available evidence suggests that random-digit-dial surveys provide an efficient method of sampling and allowing analysis of the general population.<sup>48</sup> The comparability of our sample to expected population demographics, and the fact that the response rates obtained in this study are comparable to those in similar health research, are reassuring in this regard.<sup>13</sup>

Fourth, as with most longitudinal studies, we had loss-to-follow up that potentially biases our findings. We used an analytic approach to take into account the potential influence of missingness, and we show that missingness had very little influence on the key associations of interest in this work (see Figure, available with the online version of this article).

Fifth, we present results here that pertain to period prevalence of posttraumatic stress symptoms. We cannot establish temporal associations between specific determinants that may change during a time interval (eg, income) and symptoms occurring during the interval. Therefore, we cannot fully rule out the possibility that those with symptoms may have a greater tendency to report adverse events, or even that symptoms contribute to the occurrence of stressful events. Sixth, this work assesses posttraumatic stress in the general population after a mass trauma. It is possible that the observations documented here are particular to the postmass trauma situation where the prevalence of stress may be higher than in different circumstances.

Seventh, although we collected data on a comprehensive set of potential determinants of posttraumatic stress symptoms in the aftermath of a disaster, we nonetheless did not collect data on some factors that may be important. For example, we did not obtain information on peritraumatic dissociation, a perievent emotional reaction that has been shown to be predictive of posttraumatic stress after traumatic event experiences.<sup>37</sup> This omission should be considered in drawing inference about the covariates found to be determinants of symptoms in this analysis.

Ultimately the determinants of posttraumatic stress include both the determinants of the traumatic event experiences, and the determinants of psychologic symptoms conditional on the presence of traumatic events. The likelihood of both may differ in the postdisaster circumstance compared with other circumstances, and this needs to be considered in broader generalizability of these findings.

In conclusion, we showed that in a longitudinal population-based cohort study, ongoing stressors and traumatic event experiences were both important predictors of posttraumatic stress and that female sex and Latino ethnicity were associated with posttraumatic stress independent of these variables. We suggest that interventions aimed at mitigating

the consequences of traumatic events may fruitfully focus on assistance that can help victims of trauma cope with adversity and ongoing life stressors.

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