

One-Year Follow-Up of Survivors of a Mass Shooting

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***Objective:** This report describes a 1-year follow-up study of survivors of a mass shooting incident. Acute-phase data from this incident were previously reported in this journal. **Method:** The Diagnostic Interview Schedule/Disaster Supplement was used to assess 136 survivors at 1–2 months and again a year later, with a 91% reinterview rate. **Results:** In the acute postdisaster period, 28% of subjects met criteria for posttraumatic stress disorder (PTSD), and 18% of subjects qualified for another active psychiatric diagnosis. At follow-up, 24% of subjects reported a history of postdisaster PTSD (17% were currently symptomatic), and 12% another current psychiatric disorder. Half (54%) of all 46 individuals identified as having had PTSD at either interview were recovered at follow-up, and no index predictors of recovery were identified. There were no cases of delayed-onset PTSD (beyond 6 months). Considerable discrepancy in identified PTSD cases was apparent between index and follow-up. Inconsistency in reporting, rather than report of true delayed onset, was responsible for all PTSD cases newly identified at 1 year. The majority of subjects with PTSD at index who were recovered at follow-up reported no history of postdisaster PTSD at follow-up, suggesting considerable influence of fading memory. **Conclusions:** This study's findings suggest that disaster research that conducts single interviews at index or a year later may overlook a significant portion of PTSD. The considerable diagnostic comorbidity found in this study was the one robust predictor of PTSD at any time after the disaster. Disaster survivors with a psychiatric history, especially depression, may be most vulnerable to developing PTSD and therefore may deserve special attention from disaster mental health workers.*

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Previous studies investigating the psychiatric consequences of disaster have been conducted at various points in time after the event, such as a few days or a week after, up to many years later. This and other variability in research methods make it difficult to compare findings from one study to the next, with the result that little is actually known about the longitudinal nature of symptoms and disorders after acute disasters. Prospective information is needed about the longitudinal course of posttraumatic stress disorder (PTSD) after disasters in order to better understand phenomena such as delayed onset, chronicity, and recovery over time. A few noteworthy studies, however, have employed repeated measures on a disaster population to examine the course of postdisaster symptoms and disorders over time.

Weisæth (1) studied 13 members of a Norwegian ship crew who were incarcerated and tortured after their ship was seized in Libya. Clinical interviews, conducted “as soon as possible” after the ship’s return home, found acute

PTSD in 54% initially; reinterview 6 months later detected no new delayed-onset cases and no recovery from PTSD. All four seamen with preexisting psychiatric problems developed PTSD. The same author (2, 3) evaluated 121 survivors of a Norwegian paint factory explosion and fire 1 week after the disaster, 7 months later, and 4 years later. In the high-exposure group, rates of PTSD-related problems dropped from 43% initially to 36% at 7 months and 18% at 4 years. Rates of PTSD in the low-exposure group were 22% initially, 17% at 7 months, and 2% at 4 years. Few subjects with PTSD at index were free of symptoms at follow-up. No PTSD cases were of delayed onset (more than 6 months, according to DSM criteria). Predictors of PTSD included female gender and preexisting psychopathology (specifically including PTSD related to other traumas, and character pathology). Psychiatric impairment before the disaster was an especially strong predictor of chronic PTSD.

Other researchers have also found postdisaster psychopathology to diminish over time. Steinglass and Gerrity (4) examined 39 tornado survivors and 76 flood survivors 4 and 16 months after the disasters. Rates of active PTSD ascertained by structured interview in the flood sample dropped from 15% at index to 5% at follow-up. Among high-exposure subjects, the Horowitz Impact of Events Scale identified significant difficulties in 49% of the flood sample at index and in 24% at follow-up. The tornado

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victims had higher rates: 76% at index and 41% at follow-up. Ursano's group studied a predominantly male sample of 54 community volunteers who worked as body handlers after a military disaster (5). Multimeasure assessment of PTSD at three points in time determined that 11% of workers met criteria for probable PTSD 1 month after the event, 10% at 4 months, and 2% at 13 months. More than half (58%) of 67 evacuees from cyclone Tracy in Darwin, Australia, studied by Parker (6) were identified as trauma-associated "cases" (rating of 5 or higher on the General Health Questionnaire) immediately after the disaster; rates dropped to 41% at 10 weeks and 22% at 4 months. While psychiatric problems at index were associated with the subject's perception that he or she might die or be seriously injured by the cyclone, problems at 10-week follow-up were associated only with stressors related to relocation, such as unsatisfactory housing arrangements.

One prospective study has attempted to compare individuals' consistency in reporting at two points over time. Green et al. (7, 8) studied 120 litigant survivors of the Buffalo Creek, W.Va., dam break and flood and found a 44% rate of active PTSD at index (18–26 months) that decreased to 28% by 14 years after the disaster. Only women showed significant rates of improvement over time, with a 52% rate of PTSD at index that dropped to 31% at follow-up. Individual cases of PTSD identified at index were highly discrepant from those at follow-up. Only 17% of subjects reported current PTSD at both interviews; overall, 28% went from having a diagnosis at index to not having it at follow-up (i.e., "recovered" group), and 11% who did not have the diagnosis at index did at follow-up (i.e., "delayed" group). Therefore, only 30% of the subjects with active PTSD identified at either assessment were consistent from one interview to the next. Part of the explanation for the discrepancies may lie with methodological inconsistency, since the index data were obtained from forensic evaluations and the follow-up data by structured research interview. In addition, the setting of litigation may have further affected reporting.

These studies have provided some prospective observations about the longitudinal course of disaster-related problems. First, the norm for PTSD-related problems is that they appear to diminish, but not disappear completely, over time—although a substantial proportion appears to become chronic. Second, report of who actually develops PTSD-related problems appears to differ substantially from index evaluation to subsequent inquiry. Third, the issue of delayed onset of PTSD after disasters has not been settled. Fourth, previous studies have not prospectively investigated with any systematic depth the potential predictors of outcome at follow-up.

Leading PTSD researchers have recently emphasized the need for more prospective, longitudinal studies of PTSD (9). Many of the previous prospective studies have suffered from methodological variation between assessments that prospective, longitudinal studies need to address. Because unstandardized measures and questionnaires are well known to yield inflated estimates of psychopathology compared to structured interview

methods (10), repeated, standardized assessments are essential for valid results.

The current study examined prospectively the development and course of PTSD-related problems in a universal group of survivors of a disaster assessed by structured diagnostic interview shortly after an extreme trauma and again the following year. The acute-phase data were previously reported in this journal (11). Specifically, symptoms of PTSD were evaluated in the context of diagnostic criteria in order to examine how, over time, fading memory might decay diagnoses and delayed symptom onset might create new cases.

THE INCIDENT

A lone gunman crashed his pickup truck through a wall of a crowded lunchtime cafeteria in Killeen, Tex., in October 1991. He proceeded to hold more than 100 patrons and employees of the restaurant captive as he walked around the dining room shooting victims at point-blank range, for a period of about 15 minutes. Once cornered by police, he shot himself fatally. Twenty-three others lay dead in a scene of unprecedented carnage in this small town. More detail about the incident is provided in a previous publication (11).

METHOD

More specifics of the methods are provided in the previous publication (11). A brief summary is provided here. Before the inception of the study, approval was obtained from the Washington University School of Medicine Human Studies Committee, and each subject provided written informed consent before participating in the study. Study subjects included 83 restaurant customers, 19 employees on duty and nine not present, 18 police officers, two emergency medical technicians, and five affected persons residing in nearby apartment buildings. The overall completion rate of interviews of affected subjects was 82% at index. At 1-year follow-up, 91% of index subjects were reinterviewed.

Index interviews were completed within 6 to 8 weeks after the event. Follow-up interviews were conducted a year later, 13–14 months after the event. Subjects were interviewed about their psychiatric and social status with a modified version of the Diagnostic Interview Schedule (DIS)/Disaster Supplement (12) at both index and follow-up. It elicited information about subjects' disaster experience and 10 DSM-III-R diagnoses. At follow-up, the substance abuse sections of the DIS were abbreviated: subjects were asked if they had had any change in their alcohol and drug use patterns since the last interview, and, if not, that section of the interview was skipped and the index diagnosis was entered as the follow-up diagnosis.

Rates are reported as raw numbers and percentages. Means are reported with standard deviations. For determination of associations between categorical variables, chi-square tests were used, and when expected rates in cells were less than five, Fisher's exact tests were used. Linear regressions were performed for prediction of continuous variables. Statistical significance was set at the level of $p < 0.05$, with Bonferroni correction used to correct for multiple comparisons in series of post hoc tests. Reliability of postdisaster diagnoses reported at index and follow-up was tested with the kappa coefficient. If reports of disorders are reliable, cases of postdisaster disorders reported at index will also be reported at follow-up; effects of fading of memory over time will be reflected in reduced reliability. Finally, McNemar's test was performed to measure significance of changes in rates of active disorders between index and follow-up.

TABLE 1. Predisaster and Postdisaster Diagnoses of Subjects Involved in a Mass Shooting

DSM-III-R Diagnosis	Predisaster Lifetime Diagnosis (N=136) ^a		Current Diagnosis (past month) After Shooting			
	N	%	Index (6–8 weeks) (N=136) ^a		Follow-Up (1 year) (N=124) ^a	
PTSD	14	10.4	38	28.4	22	17.7
Major depression	17	12.5	14	10.3	6	4.9
Panic disorder	0	0.0	1	2.3	1	2.4
Generalized anxiety disorder	1	0.7	1	0.7	1	0.9
Alcohol abuse/dependence	36	26.9	10	7.5	7	5.7
Drug abuse/dependence	9	6.7	0	0.0	1	0.8
Antisocial personality disorder	1	0.8	0	0.0	1	0.7
Non-PTSD diagnosis	51	37.5	25	18.4	14	11.6
Any diagnosis	57	41.9	46	34.1	31	25.0

^aTotal number of subjects varies because of missing data.

TABLE 2. Cumulative Rates of Postdisaster PTSD^a at Index and Follow-Up and Rates of Recovery for Subjects Involved in a Mass Shooting

Variable	Total	Subjects		Recovery Rate	
		N	%	N	%
Rates of PTSD					
Index interview (6–8 weeks)	136	37	27.2	—	—
Follow-up interview (1 year)	124	30	24.2	—	—
Combined data ^b	127	49	38.6	—	—
PTSD diagnosis					
No PTSD diagnosis at index or follow-up	124	78	62.9	—	—
PTSD diagnosis only at index	124	16	12.9	16	100.0
PTSD diagnosis only at follow-up	124	12	9.7	6	50.0
PTSD diagnosis at both index and follow-up	124	18	14.5	3	16.7

^aFor all subjects with PTSD, both current and recovered.

^bMet criteria for postdisaster PTSD in index or follow-up interview or both.

RESULTS

At Index

Findings vary slightly from the original report, mostly because the authors of the DIS have announced a recommendation for changes in the scoring algorithm for alcohol and drug use disorders (13) but also because it was discovered that in the original data set, one male subject had been miscoded as female. These adjustments were made in the data set. The main difference in findings with these adjustments was that the rates of alcohol and drug use disorders increased. All main analyses from the original report were reperformed with these changes, and there were no changes in significant differences in the overall findings.

Fifty-three percent of the subjects were women. Mean age was 38.7 years (SD=14.2). Eighty percent were Caucasian, 10% African American, 8% Hispanic, and 2%

other races. Subjects had completed a mean of 13.2 years (SD=2.4) of education. Two-thirds (67%) were currently married. Age, marital status, ethnicity, and predisaster history of psychiatric diagnosis did not differ between men and women, although men were slightly better educated (mean=13.9 years, SD=2.1, versus mean=12.7 years, SD=2.5) (Student's $t=2.94$, $df=129$, $p=0.004$).

Table 1 shows rates of predisaster and index psychiatric disorders at index and current (1-month) disorders a year later. More than one-third of subjects reported a predisaster psychiatric disorder. One subject had PTSD related not to the disaster but to another event. At index 27.2% (N=37) met criteria for PTSD related to the shooting. PTSD at index was not predicted by category of exposure to the disaster or by any demographic variable. Nearly one-fifth (18%) of the group met criteria for a postdisaster non-PTSD diagnosis.

Of subjects reporting PTSD at index, the majority (68%) described onset of symptoms the day of the incident. Some (22%) reported onset during the week after the incident, and a few (11%) later in the month.

Follow-Up Data

As seen in table 1, the most prevalent current disorder at follow-up was PTSD, which was present in 18% of the subjects (including one subject with PTSD unrelated to the disaster), a significant difference from the rate of 28% at index (McNemar's $\chi^2=9.00$, $df=1$, $p=0.003$). Rates of current disaster-related PTSD at index and follow-up were 27% and 17%, respectively (McNemar's $\chi^2=6.76$, $df=1$, $p=0.009$). Only 12% of all subjects reported another active psychiatric disorder, a nonsignificant decrease from the 18% reported at index (McNemar's $\chi^2=3.20$, $df=1$, $p=0.07$).

Table 2 presents rates of cumulative postdisaster (i.e., specific to the cafeteria shooting) PTSD obtained at index and follow-up and summarizes data describing rates of recovery. At follow-up, three of the 37 subjects meeting criteria for disaster-related PTSD at index were among those not reinterviewed. At follow-up, three individuals without PTSD at index interview reported having PTSD at index. Twelve subjects with new cases of disaster-related PTSD were identified. Of these, six indicated that they had already recovered, and six still had active PTSD. Of all 46 subjects with PTSD identified at index or follow-up and interviewed at both time points, 25 (54%) reported that they were recovered at follow-up. Of the 19 individuals with PTSD at index who were identified as recovered at 1 year, on the follow-up interview 16 (84%) failed to meet criteria at any time for PTSD related to the shooting. Therefore, the great majority of subjects with PTSD at index who had apparently recovered at follow-up

were not detected at reinterview because they either did not remember or for some other reason did not report enough symptoms to indicate that they had ever suffered from PTSD after the disaster. Because so few subjects who recovered reported having had PTSD, it is not possible to report systematic information on their course of recovery during the months of the year's follow-up.

Rates of disaster-related PTSD (experienced at any time since the disaster) at index and follow-up interviews were 27% and 24%, respectively. Although these rates are quite similar, further inspection reveals considerable discrepancy as to which subjects reported PTSD at either interview. (Assessment of disaster-related PTSD at follow-up ascertained the presence of PTSD at any time after the disaster. Therefore, subjects who reported postdisaster PTSD at index but no history of disaster-related PTSD at follow-up were considered discrepant in their reporting.) The kappa coefficient for the reliability of postdisaster PTSD diagnosis at index and follow-up was only 0.41. Disaster-related PTSD diagnoses among 28 subjects (21% of the entire group) were discrepant between index and follow-up. Overall, 61% of all 46 disaster-related cases of PTSD identified at either interview represented inconsistent diagnoses. Although only 15% of all subjects met criteria at both times, combining all cases of PTSD at both interviews yielded an overall disaster-related PTSD rate of 39%. Further information detailing symptom levels in relation to discrepancies in the PTSD diagnosis between index and follow-up with respect to the diagnostic criteria will be provided later in this document.

Table 3 presents index and follow-up data on individual symptoms of disaster-related PTSD. The most frequently endorsed symptom on both interviews, as well as overall, was intrusive recollections, which was acknowledged by 84%. The second most prevalent symptom both at index and follow-up, as well as overall, was exaggerated startle reflex (76%). Insomnia was a close third (74%) in frequency. No symptom showed significantly higher prevalence at follow-up than at index. Table 3 also presents rates of disaster-related PTSD symptoms by symptom group at index and follow-up. Group D (arousal) symptoms were most prevalent and group C (avoidance/numbing) least prevalent at both interviews. Absolute numbers of reported symptoms, particularly group D (arousal) symptoms, were lower at follow-up than at index.

For further data analyses, study subjects were divided

TABLE 3. PTSD Symptoms, by DSM-IV Symptom Group, at Index and Follow-Up for Subjects Involved in a Mass Shooting

Symptom Group and Symptom	Index (6–8 weeks) (N=136) ^a		Follow-Up (1 year) (N=124) ^a		Combined Index and Follow-Up ^b (N=136) ^a	
	N	%	N	%	N	%
Group B (reexperiencing) ^c						
Intrusive recollections	104	77	79	64	113	84
Nightmares	71	52	53	43	84	65
Flashbacks	47	35	43	35	68	52
Upset with reminders	47	35	58	47	76	59
Group C (avoidance/numbing) ^c						
Avoids thoughts or feelings	67	53	46	37	81	72
Avoids reminders	60	44	49	49	75	57
Amnesia	14	10	8	7	17	14
Loss of interest	41	30	29	23	53	41
Detachment/estrangement	28	21	25	20	28	25
Restricted range of affect	11	8	14	11	20	16
Sense of foreshortened future	14	10	9	7	18	14
Group D (arousal) ^c						
Insomnia	93	68	61	49	97	74
Irritability/anger	56	41	41	33	67	53
Difficulty concentrating	79	58	53	43	92	70
Hypervigilance	92	68	59	48	98	73
Exaggerated startle response	95	70	66	53	102	76
Physiologic reactivity to stimulus	27	20	29	23	47	37

^aTotal number of subjects varies because of missing data.

^bReported symptom at index or follow-up or both.

^cMean number of symptoms at index, at follow-up, and for combined index and follow-up were as follows: group B (maximum=4): 2.0 (SD=1.3), 1.9 (SD=1.5), and 3.9 (SD=2.4), respectively; group C (maximum=7): 1.8 (SD=1.5), 1.5 (SD=1.7), and 3.2 (SD=2.9); group D (maximum=6): 3.3 (SD=1.8), 2.5 (SD=2.1), and 5.8 (SD=3.5); and total (groups B, C, and D combined): 7.1 (SD=3.9), 5.9 (SD=4.7), and 12.9 (SD=7.8).

into subgroups according to assignment of disaster-related PTSD diagnoses at index and follow-up. These subgroups included 78 subjects (63%) who did not have a diagnosis of PTSD at index or follow-up, 16 (13%) who had a PTSD diagnosis only at index, 12 (10%) who had a PTSD diagnosis only at follow-up, and 18 (15%) who had PTSD diagnoses at both interviews. Of the 46 subjects with PTSD identified at either interview who were interviewed at both times, 12 (26%) were not identified at index and 16 (35%) were not identified at follow-up.

Table 4 presents data on change in number of disaster-related PTSD symptoms by symptom group, separately for index and follow-up diagnosis subgroups. Group B (reexperiencing) symptoms changed the least of any symptom group. Number of group C (avoidance/numbing) symptoms changed considerably from index to follow-up for both subjects who had a PTSD diagnosis only at index and subjects who had a PTSD diagnosis only at follow-up. Number of group D (arousal) symptoms dropped considerably from index to follow-up for the subgroup reporting PTSD only at index. Those who had a PTSD diagnosis only at index recalled an average of 4.6 fewer symptoms at follow-up than at index, and those who had a PTSD diagnosis only at follow-up reported on average 2.9 additional symptoms at follow-up.

Half (53%) of subjects reporting disaster-related PTSD at follow-up identified initial onset of symptoms the day of the incident, and most others (40%) reported onset in

TABLE 4. Change in Number of PTSD Symptoms From Index to Follow-Up, by PTSD Report Subgroup, for Subjects Involved in a Mass Shooting

Symptom Group	Group 1: No PTSD Diagnosis at Index or Follow-Up (N=78)		Group 2: PTSD Diagnosis Only at Index (N=16)		Group 3: PTSD Diagnosis Only at Follow-Up (N=12)		Group 4: PTSD Diagnosis at Both Index and Follow- Up (N=18)		Total (N=124)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group B (reexperiencing) ^a	-0.3	1.3	-0.5	1.9	0.6	0.7	0.8 ^b	0.8	-0.1	1.3
Group C (avoidance/numb- ing) ^c	-0.3 ^b	1.0	-2.3 ^b	1.1	2.2 ^b	1.3	0.0	0.9	-0.3 ^b	1.5
Group D (arousal) ^d	-0.9 ^b	1.7	-1.9 ^b	2.0	0.2	1.3	0.3	1.5	-0.8 ^b	1.8
Total (groups B, C, and D combined) ^e	-1.5 ^b	3.2	-4.6 ^b	4.2	2.9 ^b	2.8	1.1	2.1	-1.2 ^b	3.7

^aGroup 4 significantly different from groups 1 and 2 (p≤0.05); test of model difference from zero: F=4.02, df=4, 120, p=0.004.

^bSignificantly different from zero (p≤0.05)

^cGroups 2 and 3 significantly different from all other groups (p≤0.05); test of model difference from zero: F=33.77, df=4, 120, p=0.05.

^dGroup 4 significantly different from groups 1 and 2 (p≤0.05); group 2 significantly different from group 3 (p≤0.05); test of model difference from zero: F=10.65, df=4, 120, p≤0.0001.

^eGroups 1 and 2 significantly different from all other groups (p≤0.05); test of model difference from zero: F=16.02, df=4, 120, p≤0.0001.

TABLE 5. Cross-Threshold Changes in Symptoms, by DSM-IV Symptom Group, for Subjects Involved in a Mass Shooting Who Had Discordant PTSD Diagnoses at Index and Follow-Up

Subject and Symptom Groups	Individual Cross-Threshold Symptom Change	
	N	Change
No PTSD diagnosis at index (6–8 weeks); PTSD diagnosis at follow-up (1 year) (N=12)		
Group B (reexperiencing)	1	Increased by 2 symptoms
Group C (avoidance/numbing)	4	Increased by 3 symptoms
	5	Increased by 1 symptom
Group D (arousal)	0	
PTSD diagnosis at index (6–8 weeks); no PTSD diagnosis at follow-up (1 year) (N=16)		
Group B (reexperiencing)	1	Decreased by 3 symptoms
	2	Decreased by 4 symptoms
Group C (avoidance/numbing)	5	Decreased by 1 symptom
	4	Decreased by 2 symptoms
	5	Decreased by 3 symptoms
	2	Decreased by 4 symptoms
Group D (arousal)	1	Decreased by 3 symptoms
	1	Decreased by 4 symptoms
	1	Decreased by 5 symptoms
	1	Decreased by 6 symptoms

the week after the incident. One subject (3%) reported onset in the month after the incident, and another (3%) later in the first 6 months after the event. Therefore, none of the 12 newly identified PTSD cases at follow-up was of delayed onset (more than 6 months).

Table 5 lists the changes in number of symptoms reported by those who crossed the critical symptom thresholds for the diagnosis of PTSD between index and follow-up. The subgroup of 12 who had PTSD only at follow-up evidenced no change in group D (arousal) symptoms, and little change in group B (reexperiencing) symptoms. The majority of increases occurred in group C (avoidance/numbing) symptoms. (Two subjects who had PTSD only

at follow-up had no increase in number of symptoms at follow-up; their diagnosis of PTSD was due to an increase in time and/or functional severity criteria.) The subgroup of 16 who reported PTSD at index but not at follow-up showed cross-threshold changes in all three symptom groups, with the greatest change occurring in group C (avoidance/numbing) symptoms. Overall, half the cross-threshold changes in the group that had PTSD only at follow-up were accounted for by an increase of one symptom. In the group reporting PTSD at index but not at follow-up, however, only a minority (five of 23) of threshold transitions was accounted for by a decrease of one symptom.

Other diagnoses also showed inconsistencies between index and follow-up (when subjects who were interviewed at both times were counted). Of 23 cases of all postdisaster major depression identified at either index or follow-up, 13 (57%) were identified at index and 17 (74%) at follow-up (kappa=0.39). Of 11 cases of postdisaster alcohol use disorder identified at index or follow-up, only five (45%) were identified at index and all 11 at follow-up (kappa=0.46). Of 34 non-PTSD postdisaster diagnoses identified, 22 (65%) were identified at index and 25 (74%) at follow-up (kappa=0.45).

A series of bivariate analyses was performed to predict postdisaster disorders (total diagnoses identified in both interviews, current psychiatric disorder at follow-up, and recovery from PTSD) from independent predictor variables of diagnosis (pre-disaster and acute postdisaster), demographic characteristics (gender, age, race, education, and marital status), and disaster exposure subgroup (classified categorically as injured, noninjured eyewitness, witnessed aftermath only, on site but not direct witness, and associated but not on site). Total rate of disaster-related PTSD (including all cases identified at index or fol-

low-up or both) for women (47%) was higher than that for men (29%) ($\chi^2=4.44$, $df=1$, $p=0.03$). No other demographic variables predicted PTSD or any other disorder, and disaster exposure subgroup was not associated with any disorders. Among individuals without comorbid psychopathology, no demographic variables aside from gender predicted PTSD.

PTSD was associated with other psychopathology. Considering the total of all cases of PTSD detected in either interview, three-fourths (76%) of women with a predisaster diagnosis at index developed PTSD at some time after the disaster, compared to only 34% of women without a diagnosis (Pearson $\chi^2=10.35$, $df=1$, $p=0.001$). This relationship was not significant for men (33% compared to 25%) (Pearson $\chi^2=0.50$, $df=1$, $p=0.48$). Acute postdisaster comorbid psychiatric illness at index also predicted PTSD: 83% of subjects reporting another acute postdisaster diagnosis at index reported disaster-related PTSD at some time after the disaster, compared with 28% of those without another identified disorder at index (Pearson $\chi^2=25.01$, $df=1$, $p=0.001$). Report of any diagnosis at any time (before the disaster, after the disaster, or follow-up) was associated with development of PTSD: 61% of subjects reporting another lifetime disorder developed PTSD, compared to 31% of others (Pearson $\chi^2=9.13$, $df=1$, $p=0.003$). Forty-one percent of subjects who developed disaster-related PTSD at any time after the disaster had a lifetime comorbid psychiatric disorder.

Major depression was the one diagnosis that was consistently associated with PTSD. Predisaster depression was associated with any report of postdisaster PTSD, which developed in 75% of subjects with a history of depression, compared with only 33% of those without it (Pearson $\chi^2=10.25$, $df=1$, $p=0.001$). Report of major depression at index predicted PTSD, which developed in 100% of subjects with index depression and 31% of those without it (Pearson $\chi^2=25.05$, $df=1$, $p=0.001$). Report of lifetime depression was associated with development of PTSD: 81% of subjects with any depression developed PTSD, compared with 32% of others (Pearson $\chi^2=14.06$, $df=1$, $p=0.001$).

No diagnostic or demographic variable predicted recovery from PTSD at follow-up. Subjects who recovered from PTSD did not report significantly fewer symptoms at index than those who did not recover.

The group that reported PTSD at follow-up but not at index reported marginally higher rates of predisaster psychiatric diagnosis (67% versus 35% of others; Fisher's exact $p=0.06$), but no other diagnostic or demographic variables characterized this group. Membership in the group reporting PTSD at index but not at follow-up was not associated with any diagnostic or demographic variable.

DISCUSSION

Although disasters are disconcertingly prevalent in modern culture, prospective systematic studies of them have been few, in part because of the recognized difficul-

ties inherent in disaster research (14). The current study has broken new ground as a prospective, longitudinal (1-year), systematic investigation of a relatively large population of survivors of a severe disaster (large-scale mass murder) with high rates of subject participation.

Observations from previous studies that PTSD diminishes with time were supported by this study. Active disaster-related PTSD decreased from 27% to 17% between index and 1 year. Comorbid disorders also decreased, from 18% to 12%, but this difference was nonsignificant. This study's findings are consistent also with previous studies that have observed poor agreement between acute-phase and longitudinal assessments of responses to trauma. Baseline interviews failed to detect 26% of subjects who would ever affirm disaster-related PTSD in either of the two interviews; follow-up interviews failed to detect 35%. Overall, 61% of all identified PTSD reported at either interview was unidentified by the single index or follow-up interview. Combined rates of PTSD in this study were 24% higher than rates determined at follow-up and 53% higher than rates determined at index. Therefore, research that conducts disaster interviews only at baseline or at 1 year should be expected to overlook a significant portion of potentially identifiable total cases.

Although a possible explanation for the discrepancy in PTSD cases identified between index and follow-up might simply be that crossing the threshold for diagnosis was due to lack of a critical symptom, the data indicate a more complicated scenario. In about half of the cases, report of PTSD diagnosis at follow-up when it was not reported at index resulted from a critical fluctuation of just one symptom crossing the diagnostic threshold. Report of PTSD at index but not at follow-up was not usually explained by critical fluctuation in one symptom. Report of PTSD at follow-up in individuals without PTSD at index was largely attributable to higher rates of group C (avoidance/numbing) symptoms at follow-up. Report of PTSD at index but not at follow-up was similarly attributable to a change in number of group C symptoms and also, to some extent, reduced numbers of group D (arousal) symptoms at follow-up. Therefore, fluctuation of avoidance/numbing symptoms resulted in most of the discrepancy in reporting of history of postdisaster PTSD between index and follow-up. One could imagine that intrusive reexperiencing of the event and physiological arousal might be remembered more reliably than the less conspicuous responses of avoidance and numbing.

While the index PTSD cases identified at follow-up of subjects who had not reported PTSD at index may have arisen from failure to detect PTSD at index, they could, alternatively, represent overreporting at follow-up. The finding that the group with PTSD at follow-up but not at index reported marginally more predisaster psychopathology at index suggests that this psychopathology could predispose some individuals to report more symptoms with the passage of time. However, known proclivities of populations to report less psychopathology at follow-up interviews (8) and the notorious dele-

terious effects of time on recall of symptoms would argue against simple overreporting in most of these cases. The data suggest that many of the subjects reporting index PTSD at follow-up but not at index may be accounted for by slightly subthreshold symptoms at index that worsened with time. The passage of time in these individuals may have distorted memory of the onset of symptoms, with retrospective attribution of their onset closer to the time of the event than they had actually occurred.

Yet another possible explanation for the discrepancy in PTSD diagnoses is potential lack of sensitivity of the structured interview for the diagnosis of PTSD. Although lack of sensitivity would be expected to be operative equally at either interview, it could introduce some discrepancy resulting in reduction of reliability of the diagnoses. While this may be possible for PTSD, reliability between clinician and DIS for other diagnoses has been well documented (15). Further study of reliability over time of PTSD diagnosis by the DIS is needed.

None of the PTSD cases newly identified at follow-up represented true delayed-onset cases according to subjects' reports of their symptom onsets. Therefore, all the discrepancy in cases identified between baseline and follow-up appears due to differences in reporting, rather than to actual delay of symptom development. Because most subjects who reported PTSD at index but not at follow-up reported no memory of the disorder, recollection of symptoms may be the critical factor in decay of overall PTSD rates with increasing time to assessment after a disaster, a phenomenon previously suggested by other researchers (10). The absence of bona fide delayed-onset PTSD in this prospective study confirms the absence of delayed PTSD in a previous longitudinal study (3) but contrasts with reports of significant delayed PTSD in retrospective studies of combat veterans (16–18). This finding needs to be confirmed in other disaster populations to determine whether delayed-onset PTSD is a characteristic of combat veterans that is not present in disaster populations.

The only demographic predictor of PTSD was female gender. The only consistent predictor of PTSD at index and at follow-up was other psychopathology. At 1 year, no other predictors of active PTSD were found, nor were any predictors of recovery from PTSD. This study found considerable diagnostic comorbidity, which was the one robust predictor of PTSD at any time after the disaster. The association of prior psychiatric disorder with postdisaster PTSD suggests that disaster victims with a psychiatric history may deserve special attention, since they may be at heightened risk for developing PTSD after a disaster. This is especially true for women with prior psychopathology, among whom 76% developed postdisaster PTSD. The findings of this study further indicate that studies of postdisaster syndromes should not limit investigation to PTSD, since this diagnosis makes up only part of the psychopathology to be found after disasters.

More study of postdisaster adjustment is needed over

a lengthier period in order to determine whether additional healing occurs with passing years and whether memory further alters report of symptoms with the accumulation of yet more time. Comparison of the findings in the present study with those of studies of different types of disasters may help to determine if the results of this study are unique to traumatic events due to terrorism or whether they may apply also to populations afflicted by natural and accidental technological disasters.

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