Psychological Sequelae Resulting From the 2004 Florida Hurricanes: Implications for Postdisaster Intervention

| Ron Acierno, PhD, Kenneth J. Ruggiero, PhD, Sandro Galea, MD, DrPH, Heidi S. Resnick, PhD, Karestan Koenen, PhD, John Roitzsch, PhD,
Michael de Arellano, PhD, John Boyle, PhD, and Dean G. Kilpatrick, PhD

The 2004 hurricane season brought Florida an unprecedented 4 hurricanes (named Charley, Frances, Ivan, and Jeanne) over a 7-week period between August 13 and September 25, 2004. These hurricanes inflicted tremendous damage, including an estimated 124 deaths and US$40 billion in costs to insured property.[1–3] Three of these storms were classified as major hurricanes at landfall (i.e., maximum sustained wind speed >110 mph), the greatest number of major hurricanes ever recorded for Florida in a single season.[4]

To date, the best estimates of the health-related impact of the 2004 hurricane season come from a Centers for Disease Control and Prevention report.[1] That report summarized data from a random-digit dial telephone interview conducted between November and December 2004 with a sample of 1706 participants representing all 67 counties in Florida. Although results from this survey should be interpreted cautiously in light of the low (43%) response rate, major findings included the following: (1) the quality of drinking water, sewage disposal, and food protection were cited as most important among environmental concerns associated with hurricanes; (2) nearly 20% reported at least "moderate" damage to their residence (i.e., US$500 in damage), and 8% reported "severe" or "catastrophic" damage; (3) 4% experienced physical injuries; (4) nearly half of respondents employed at the time of the hurricanes missed work or lost their jobs, and 39% missed work for at least 5 days; and (5) among persons with medical conditions, 5% noted a worsening of their condition, 14% reported difficulties obtaining medication, and 9% reported barriers to accessing essential medical equipment. Notably, many of these consequences were approximately as prevalent in counties that were versus those that were not in the direct path of the hurricanes. This assessment also found that 11% of participants reported anxiety, nervousness, or worry; 6% reported

Objectives. Data are limited regarding mental health effects of disasters such as hurricanes. We sought to determine the prevalence of and major risk factors associated with posttraumatic stress disorder (PTSD), generalized anxiety disorder, and major depressive episode 6 to 9 months after the 2004 Florida hurricanes.

Methods. Random-digit dialing was used to recruit a representative population sample of 1452 hurricane-affected adults.

Results. Posthurricane prevalence for PTSD was 3.6%, for generalized anxiety disorder was 5.5%, and for major depressive episode was 6.1%. Risk factors varied somewhat across disorders, with the exception of previous exposure to traumatic events, which increased risk of all negative outcomes.

Conclusions. Storm exposure variables and displacement were associated primarily with PTSD. Notably, high social support in the 6 months preceding the hurricanes protected against all types of disorders. (*Am J Public Health.* 2007; 97:S103–S108. doi:10.2105/AJPH.2006.087007)

sadness, loss of appetite, or difficulty sleeping; and 4% reported reduced mental capacity to study or work.

Findings from the Centers for Disease Control and Prevention report provide some insight into the degree of physical threat, loss, bereavement, and social and community disruption experienced by Florida residents in the short-term aftermath of the 2004 hurricanes. Little is known, however, about the mental health impact of these hurricanes and associated risk factors. Previous research demonstrated that emotional effects of natural and manmade disasters can be quite significant[5,6] and that negative postdisaster mental health outcomes are associated with long-term problems in health, recovery, and economic burden.[5,7–10] Although recent epidemiological data indicate general population 12-month prevalences of 3.5% for posttraumatic stress disorder (PTSD), 6.7% for depression, and 3.1% for generalized anxiety disorder,[11] postdisaster 12-month prevalences for these disorders are likely higher. For example, Kessler et al[12] found 12-month prevalence of PTSD secondary to natural disasters to be 11.3%; however, this finding was only with respect to disasters involving fire, and no disaster-specific prevalences were offered for depression or other anxiety disorders.

A second general population study of natural disaster victims[13] observed elevations in 6 of 10 symptom scales measuring anxiety and depression but did not specifically assess PTSD, depression, or generalized anxiety disorder at the diagnostic level and did not disaggregate findings in terms of hurricane exposure. Surprisingly little information is available from epidemiologically-based studies on the prevalence of PTSD, depression, and anxiety in adults after hurricanes. However, both published and unpublished data from hurricane and other natural disaster survivors (J. Freedy et al., unpublished data, 1991.)[14,15] indicate that peristorm and poststorm exposure variables that include displacement and resource loss (e.g., property damage) play a role in determining mental health outcomes.

We sought to determine the prevalence of PTSD, generalized anxiety disorder, and major depressive episode among Florida residents living in counties directly affected by the 2004 hurricanes and to identify risk and protective factors associated with these disorders. We focused on PTSD, generalized anxiety disorder, and major depressive episode, because these disorders are among the most common in the aftermath of disasters and traumatic events.[10,12,13,16–18]
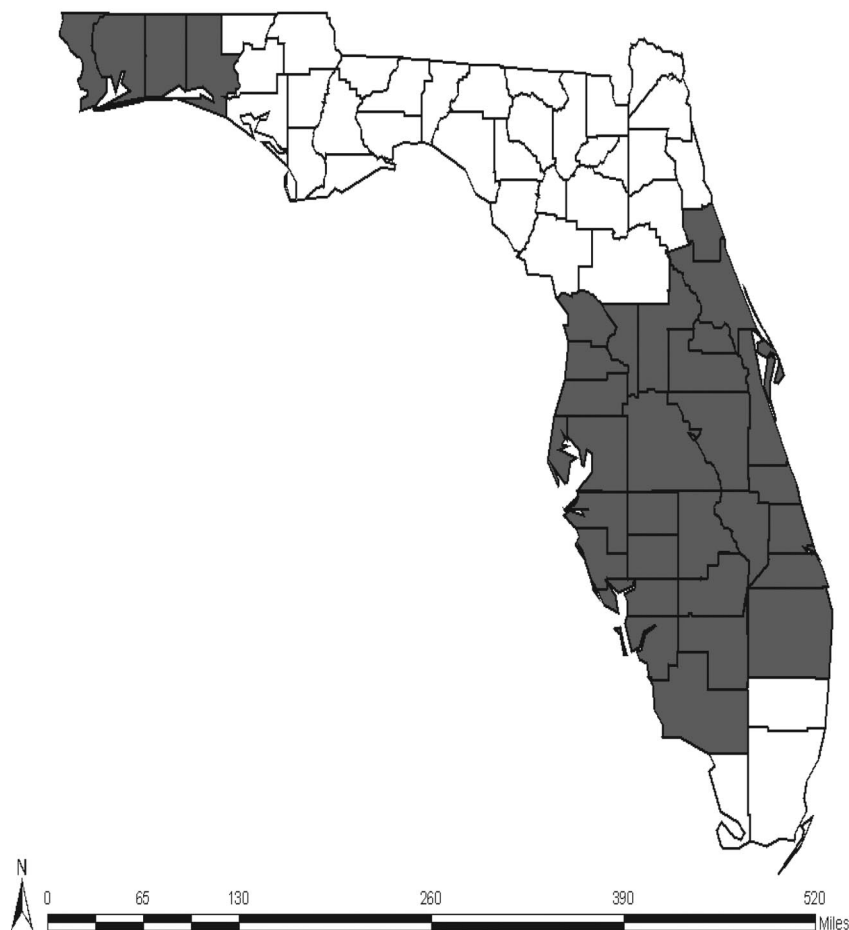
Note. Those counties affected by the 2004 hurricanes and included in the study are shaded gray.

FIGURE 1—Florida counties (n = 33) significantly affected by the 2004 hurricanes.

METHODS

Data Collection and Sample

Data were collected from a sample of 1452 adults aged 18 years and older who resided in households with telephones in Florida counties that were in the direct path of 1 or more of the 2004 hurricanes (see Figure 1) and who provided complete data on age and gender (for sample weighting purposes). The original sampling frame consisted of the 38 Florida counties that were exposed to hurricane-force winds,[19] but this was subsequently reduced to 33 counties after we terminated sampling from 5 counties (Bay, Broward, Holmes, St. Johns, and Washington) for which a relatively small proportion of the area and population experienced hurricane-strength winds (cases from these 5 counties were not included in the final sample). The sampling frame also included an oversample of adults aged 60 years and older to address research questions specific to older adults as part of another study. As a result, the final (unweighted) sample consisted of 374 adults aged 18 to 59 years (25.8%) and 1078 adults aged 60 years and older (74.2%). Data were weighted by gender and age to bring the sample in line with US Census 2000 estimates of the distribution of these demographics in the population of Florida adults living in the 33 counties from which we sampled. No weighting by racial/ethnic status was necessary because sample distributions were highly comparable to

population estimates for the 33 Florida counties in the sampling frame based on 2000 Census data.

Random-digit dialing was used to select households to screen for eligibility. In instances where multiple eligible participants were present, the most recent birthday method was used to select the eligible respondent. Land-line telephone interviews were conducted between April 5 and June 12, 2005. Up to 5 attempts were made to contact an adult at each telephone number. The overall cooperation rate (i.e., [completes + screen-outs] divided by [completes + screen-outs + refusals before screen + qualified refusals]) was 70%. The cooperation rate among eligible individuals (i.e., completes divided by [completes + qualified refusals]) was 81%.

Study Instruments

A structured computer-assisted telephone interview administered in English or Spanish included the following sections: basic demographics, hurricane exposure characteristics, social support, and posthurricane PTSD, generalized anxiety disorder, and major depressive episode. The interview was approximately 26.5 minutes in length.

Hurricane Exposure. Hurricane exposure variables were selected based on our experience with victims of other natural disasters, including hurricanes,[14–16] and focused on both perihurricane and posthurricane storm impact on personal resources, such as property and shelter. Thus, we assessed whether participants were physically present for hurricane-force winds, whether they had any damage to property, and whether they were displaced for at least a week. To more fully characterize resource losses, we also assessed whether total incurred losses (i.e., irrespective of insurance coverage) were greater than US $10 000 and whether actual incurred out-of-pocket losses were greater than US $1000. We selected these levels of resource loss (displacement for more than a week, dollar losses irrespective of insurance over US $10 000, and uninsured dollar losses more than US $1000) after review of archival data from Hurricane Hugo survivors in which these approximate figures (adjusted for inflation) predicted negative outcomes.

Social Support. Social support was assessed for the 6 months immediately before the hurricane.[10] Five items measured 3 aspects of social support: emotional (e.g., "someone available to love you and make you feel wanted"), instrumental (e.g., "someone available to help you if you were confined to bed"), and appraisal (e.g., "someone available to give good advice in a crisis"). Answers (on a 4-point scale) ranged from "none of the time" (1) to "all of the time" (4),? and respondents were categorized in a manner consistent with a previous study,[10] with scores divided into low (lowest third of the sample) or high (upper two thirds of the sample) social support.

PTSD. We assessed PTSD since the hurricanes using the National Women's Study PTSD Module (NWS-PTSD Module),[20] a widely used measure in population-based epidemiological research originally modified from the Diagnostic Interview Schedule. Research on the NWS-PTSD Module has provided support for concurrent validity and several forms of reliability (e.g., temporal stability, internal consistency, and diagnostic reliability).[16,21] The NWS-PTSD Module was also validated in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*), PTSD Field Trial against a well-established structured diagnostic interview administered by trained mental health professionals (Structured Clinical Interview for *DSM-IV*),[22] where the interrater κ coefficient was 0.85 for the diagnosis of PTSD, and comparisons between the NWS-PTSD Module and Structured Clinical Interview for *DSM-IV* yielded a κ coefficient of 0.71 for current and 0.77 for lifetime PTSD.[23] We defined PTSD based on *DSM-IV* symptom requirements (i.e., 3 avoidance, 1 intrusion, and 2 arousal symptoms), including functional impairment. Among individuals screening into the NWS-PTSD Module, Cronbach's $\alpha = .86$ for symptoms assessed with this sample.

Similar to Hoge et al,[24] we generated 2 classifications of PTSD, 1 being relatively more conservative than the other. The first classification, PTSD-general, was formed to permit comparison of PTSD prevalence observed in this study with previous research in this area and required participants to meet all traumatic event exposure, symptom,

and functional impairment criteria in the time period since the hurricanes. Note that exposure to traumatic events, rather than exposure to the hurricanes, per se, was required. Thus, PTSD-general referred to presence of the disorder that was not necessarily because of hurricanes, whereas the second classification, PTSD-hurricane, included the additional requirements that participants who met PTSD criteria were also present for hurricane-force winds and indicated that they experienced extreme fear during exposure to the hurricane.

Generalized Anxiety Disorder. Generalized anxiety disorder since the hurricanes was measured using a slightly modified version of the Structured Clinical Interview for *DSM-IV*[22] with questions corresponding directly to *DSM-IV* criteria using yes/no response options. The diagnosis required excessive and poorly controlled anxiety and worry occurring more days than not for a period of 6 to 9 months ("since the hurricanes"), as well as 3 of 6 hallmark generalized anxiety disorder symptoms, including restlessness, fatigue, concentration problems, irritability, tension, and sleep disturbance. This scale showed good internal consistency in the current sample among individuals screening into the module (Cronbach's $\alpha = .85$).

Major depressive episode. We measured major depressive episode since the hurricanes using structured interview questions modified from the Structured Clinical Interview for *DSM-IV*[22] that targeted major depressive episode criteria using yes or no response formats for each *DSM-IV* symptom. Following *DSM-IV* criteria, respondents met criteria for major depressive episode if they had 5 or more depressive symptoms for at least 2 weeks. Support for internal consistency and convergent validity exist for this measure.[21] For this sample of individuals screening into the module, Cronbach's $\alpha = .82$.

Statistical Analyses

We used 2-tailed bivariate χ^2 analyses to examine psychological outcomes in relation to demographic, hurricane exposure, social support, and previous traumatic stressor exposure variables. Next, all of the demographic variables, as well as risk variables that

reached a cutoff of $P<.10$ in bivariate analyses, were examined with respect to their relative risk of each psychopathological outcome in 4 separate logistic regression analyses. Because data were weighted, we used the SUDAAN statistical package (Research Triangle Institute, Research Triangle Park, NC) for bivariate and multivariate analyses. For significance testing, α was set a priori at $P<.05$.

RESULTS

Sample

Characteristics of the weighted sample are as follows. Of the 1452 participants, 754 (51.9%) were women and 698 (48.1%) were men. Mean age was 49.6 years (SD=18.4). Racial/ethnic distribution for the sample was comparable to the population distribution according to Census 2000 data. Within the sample, 1098 participants were white (76.4%), 164 were African American (11.4%), 129 were Hispanic (9.0%), 24 were Asian or Pacific Islander (1.7%), 18 were Native American or Alaskan Natives (1.3%), and 5 were biracial (0.3%). Data were missing from 14 participants who chose not to self-identify a racial/ethnic status.

Prevalence Estimates for Disorders

Table 1 shows prevalence estimates for disorders occurring during the approximate 6- to 9-month time frame since the hurricanes. The prevalence of PTSD-general was 3.6% (affected Florida county population estimate=267 000 of 7.4 million adults), and the prevalence of PTSD-hurricane was 1.4% (population estimate=104 000). generalized anxiety disorder criteria were met by 5.5% (population estimate=408 000), and major depressive episode was reported by 6.1% (population estimate=453 000). Overall, 10.9% (n=159; population estimate=806 600) met criteria for at least 1 of the 3 disorders (PTSD-general, generalized anxiety disorder, or major depressive episode), 1.9% (n=27) met criteria for both PTSD-general and major depressive episode, 1.1% (n=17) met criteria for both PTSD-general and generalized anxiety disorder, 2.0% (n=29) met criteria for both major depressive episode and generalized anxiety disorder, and 0.7% (n=10) met criteria for all 3 disorders.

TABLE 1—Weighted Prevalence Estimates and Results of Weighted Bivariate Analyses: Florida, 2004

Variable	Total No. (%)	PTSD-General		PTSD-Hurricane		Generalized Anxiety Disorder		Major Depressive Episode	
		No. (%)	P	No. (%)	P	No. (%)	P	No. (%)	P
Total	1452 (100)	52 (3.6)		20 (1.4)		80 (5.5)		89 (6.1)	
Age, y			.172		.586		.953		.006
≥ 60	465 (32)	12 (2.5)		5 (1.1)		25 (5.4)		15 (3.3)	
18–19	987 (68)	41 (4.2)		15 (1.5)		54 (5.5)		73 (7.4)	
Gender			.901		.522		.013		.343
Male	698 (48.1)	24 (3.5)		8 (1.1)		20 (2.9)		34 (4.8)	
Female	753 (51.9)	28 (3.7)		13 (1.7)		59 (7.9)		55 (7.3)	
Ethnicity			.166		.783		.025		.079
Hispanic	129 (9)	11 (8.2)		2 (1.7)		18 (13.9)		20 (15.4)	
Non-Hispanic	1306 (91)	42 (3.2)		18 (1.4)		61 (4.7)		68 (5.2)	
Low income, US $			.151		.091		.733		.937
<$15 000	149 (12)	9 (6.2)		6 (3.9)		7 (4.8)		9 (6.2)	
≥$15 000	1089 (88)	33 (3)		14 (1.3)		60 (5.5)		65 (6)	
Present for hurricane winds			.487		NA		.37		.919
Yes	1266 (87.3)	48 (3.8)		20 (1.6)		73 (5.8)		77 (6.1)	
No	184 (12.7)	4 (2.4)		0 (0)		6 (3.2)		11 (5.8)	
Property damage			.737		.096		.475		.700
Yes	928 (63.9)	36 (3.9)		18 (1.9)		56 (6)		59 (6.4)	
No	524 (36.1)	17 (3.3)		3 (0.6)		24 (4.6)		29 (5.5)	
Incurred damage, US $			.237		.009		.166		.109
≥$10 000	204 (14)	12 (5.9)		10 (4.7)		17 (8.2)		7 (3.3)	
<$10 000	1248 (86)	41 (3.3)		11 (0.9)		64 (5.1)		81 (6.5)	
Time displaced from home			.075		.014		.001		.755
≥1 week	55 (3.8)	6 (11.1)		5 (9)		11 (20.3)		3 (5.2)	
<1 week	1398 (96.2)	48 3.4		15 (1.1)		69 (4.9)		85 (6.1)	
Out-of-pocket expenses incurred, US $			.064		.046		.023		.519
≥$1000	461 (31.8)	27 (5.9)		13 (2.8)		39 (8.5)		23 (5)	
<$1000	991 (68.2)	26 (2.6)		8 (0.8)		41 (4.1)		65 (6.6)	
Experienced significant fear of injury or death during prior trauma			.027		.007		<.001		.002
Yes	686 (47.2)	41 (6)		18 (2.6)		61 (8.9)		67 (9.7)	
No	766 (52.8)	11 (1.5)		3 (0.4)		18 (2.4)		22 (2.9)	
Social support			.006		.004		<.001		<.001
Low	492 (35.2)	36 (7.3)		15 (3.1)		49 (9.9)		65 (13.2)	
High	906 (64.8)	15 (1.7)		4 (0.4)		29 (3.2)		19 (2.1)	

Note. PTSD = posttraumatic stress disorder. NA = not applicable. Subgroup numbers do not always equal the total because of missing data or the effects of weighted data.

Bivariate Analyses

Table 1 also shows the odds ratios and results of χ^2 analyses. Risk factors common across disorder types included previous exposure to traumatic stressors and low social support in the 6 months before the hurricane. Risk factors common to the anxiety disorders (i.e., PTSD-general or PTSD-hurricane and generalized anxiety disorder) also included storm exposure variables, such as being

displaced for more than 1 week and having out-of-pocket expenses of greater than US $1000. Younger age was a risk factor only for major depressive episode, and female gender and Hispanic ethnicity were risk factors only for generalized anxiety disorder.

Multivariate Analyses

Logistic regression models are presented in Table 2 and were created for each of the 4 negative psychological outcomes using demographic variables in addition to risk variables that were associated with increased likelihood of the disorder (at $P<.10$) in bivariate analyses. In the final models, low social support and previous exposure to PTSD criterion A stressors (defined on the basis of direct exposure accompanied by extreme fear, rather than exposure, per se) were associated with PTSD-hurricane, generalized anxiety disorder, and major depressive episode. A key storm exposure variable that was independently predictive of outcome was being displaced from one's home (odds ratio [OR]= 4.6 for PTSD-general and OR=5.8 for PTSD-hurricane), and this association was confined to the PTSD outcomes.

DISCUSSION

Although 87% of participants in the sampling frame reported exposure to hurricane force winds, prevalence of mental disorders was low. In fact, prevalences for all disorders were very much in line with general population estimates found in the new National Comorbidity Study.[11] However, hurricane-affected counties contained significantly greater proportions of older adults relative to national averages, and this age group typically reports psychopathology symptom levels lower than the general population. Thus, effects of the hurricanes on emotional functioning may have been significant, although the cross-sectional nature of this study precludes conclusions regarding causality. Nonetheless, the dense population of our coastlines indicates that these relatively low prevalences still translate into significant numbers of individuals who may be negatively emotionally affected by hurricanes. In the present sample, more than 1 in 10 (an estimated 800 000 people) met full criteria for at least 1 of the 3 studied disorders, and more

TABLE 2—Weighted Logistic Regression for Risk Factors for PTSD-General, PTSD-Hurricane, Generalized Anxiety Disorder (GAD), and Major Depression Episode (MDE): Florida, 2004

Variable	PTSD-General, OR (95% CI)	PTSD-Hurricane, OR (95% CI)	GAD, OR (95% CI)	MDE, OR (95% CI)
Age, y				
≥ 60	0.97 (0.38, 2.46)	1.13 (0.33, 3.81)	1.50 (0.79, 2.85)	0.60 (0.30, 1.21)
Gender				
Female	1.23 (0.42, 3.58)	1.86 (0.60, 5.83)	2.80 (1.08, 7.24)	2.33 (0.86, 6.35)
Ethnicity				
Hispanic	2.62 (0.39, 17.80)	0.49 (0.05, 5.00)	3.27 (0.88, 12.16)	2.65 (0.68, 10.32)
Low income, US $				
< $15 000	1.56 (0.50, 4.84)	2.04 (0.48, 8.64)	0.81 (0.32, 2.06)	0.86 (0.25, 2.93)
Property damage				
Yes			1.62 (0.23, 11.28)	
Amount of incurred damage, US $				
> $10 000			2.99 (0.99, 9.01)	
Time displaced from home				
>1 week	4.59 (1.03, 20.49)	5.80 (1.34, 25.21)	3.83 (0.97, 15.18)	
Out-of-pocket expenses incurred, US $				
> $1000	1.30 (0.49, 3.43)	1.07 (0.22, 5.09)	1.96 (0.78, 4.90)	
Experienced significant fear of injury or death during prior trauma				
Yes	2.11 (0.44, 10.15)	5.74 (1.13, 29.24)	3.72 (1.78, 7.79)	2.64 (1.03, 6.81)
Social support				
Low	2.59 (0.71, 9.48)	7.92 (1.54, 40.63)	2.68 (1.10, 6.51)	6.15 (2.60, 14.53)

Note. OR = odds ratio; CI = confidence interval; PTSD = posttraumatic stress disorder. For all logistic regressions, nonsignificant risk ratios were evident from CIs that spanned the value 1; these risk ratios should be considered equal to 1: no increased or decreased risk.

than 100 000 adults met criteria for hurricane-specific PTSD as defined in our study.

In bivariate analyses, generalized anxiety disorder, and PTSD shared some hurricane exposure risk factors; however, generalized anxiety disorder was observed at 50% greater prevalence than PTSD. Therefore, increased attention to pervasive and intrusive worry behaviors and distress may be justified after natural disasters and other traumatic exposure events. Indeed, exposed individuals who do not develop sufficient symptoms to meet diagnostic criteria for PTSD may well experience significant symptoms of and functional impairment associated with generalized anxiety disorder. Relevance of generalized anxiety disorder may be particularly noteworthy in the aftermath of hurricanes (relative to other types of disasters) because of the nature of the hurricane season, which presents repeated potential threats over an extended period of time thereby heightening vigilance and anticipatory concerns of residents in the form of worry behaviors. On the other hand, the overall prevalence of generalized anxiety disorder in this sample only slightly exceeded that found in other epidemiological studies[11] (this notwithstanding the fact that the sample was overrepresented with older adults who generally evince lower than average symptomatology), and symptoms of this disorder that were present were not necessarily because of the hurricane and may have even predated the disaster. The question of generalized anxiety disorder secondary to exposure to natural or manmade disasters, therefore, warrants further study.

The finding that increased risk of psychological problems was independently associated with previous exposure to potentially traumatic events, significant displacement, and low social support preceding the hurricanes is consistent with previous research.[10,25] Individuals who share these risk factors may be particularly vulnerable in the aftermath of a natural disaster and may be a group toward which secondary preventive treatment or educational interventions should be targeted. By contrast, the consistently strong protective effect of informal social support in this study of hurricane-affected individuals was noteworthy. Help or assistance from neighbors (e.g., food and shelter), emotional support, and simple companionship delivered by members of churches, synagogues, mosques, senior centers, schools, and other public or semipublic institutions may well be among the best and most efficient approaches to community-based intervention after natural disasters, such as hurricanes, for the majority of affected individuals.

There are several limitations of this research worthy of mention. First, psychological symptoms were measured approximately 6 to 9 months after hurricane exposure, and intervening stressors, such as employment or income loss, death of spouses or close relatives, or extended displacement, may have accounted for or co-contributed to symptomatology over and above that caused by acute exposure to hurricanes, per se. Longitudinal research is needed in which assessment of the effects of these secondary stress events can be accomplished. Second, in epidemiological studies, it is difficult to isolate psychopathology in response to discrete stressor events from preexisting psychopathology. This difficulty is exacerbated by the fact that a large proportion of mental illness goes both unreported and untreated, particularly in samples in which older adults are well represented. Although we attempted to disentangle these prevalence estimates with respect to PTSD caused by hurricane exposure versus PTSD because of other traumatic stressors, we did not attempt to do so for the other disorders. Thus, results reported here are correlational, not necessary causal, with respect to hurricane exposure. Third, whereas prehurricane levels of social support were predictive of outcome, it may well be the case that postevent social support, which was not measured here, is also related to functioning. Although our focus was on risk and protective factors which, by definition, precede index events, our assessment of outcomes occurred well after the index event, and this potentially intervening variable should not be ignored. ∎

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