ORIGINAL RESEARCH

Vulnerable, But Why? Post-Traumatic Stress Symptoms in Older Adults Exposed to Hurricane Sandy

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ABSTRACT

Objective: Drawing on pre-disaster, peri-disaster, and post-disaster data, this study examined factors associated with the development of post-traumatic stress disorder (PTSD) symptoms in older adults exposed to Hurricane Sandy.

Methods: We used a sample of older participants matched by gender, exposure, and geographic region ($N = 88$, mean age = 59.83 years) in which one group reported clinically significant levels of PTSD symptoms and the other did not. We conducted *t-tests*, chi-square tests, and exact logistic regressions to examine differences in pre-disaster characteristics and peri-disaster experiences.

Results: Older adults who experienced PTSD symptoms reported lower levels of income, positive affect, subjective health, and social support and were less likely to be working 4 to 6 years before Hurricane Sandy than were people not experiencing PTSD symptoms. Those developing PTSD symptoms reported more depressive symptoms, negative affect, functional disability, chronic health conditions, and pain before Sandy and greater distress and feelings of danger during Hurricane Sandy. Exact logistic regression revealed independent effects of preexisting chronic health conditions and feelings of distress during Hurricane Sandy in predicting PTSD group status.

Conclusions: Our findings indicated that because vulnerable adults can be identified before disaster strikes, the opportunity to mitigate disaster-related PTSD exists through identification and resource programs that target population subgroups. (*Disaster Med Public Health Preparedness*. 2016;10:362-370)

Key Words: PTSD, Hurricane Sandy, older adults

Hurricane Sandy struck the eastern United States on October 29, 2012. As the largest Atlantic hurricane on record,[1] it was responsible for 147 deaths, at least 650,000 damaged or destroyed homes, power losses affecting 8.5 million people, and many personal injuries.[2] The storm also resulted in adverse psychological outcomes, where like in other disasters higher levels of exposure were linked to higher incidences of post-traumatic stress disorder (PTSD).[3-8]

In New Jersey, Hurricane Sandy carried additional harmful effects for older adults in particular; 65% of the deaths associated with the storm included persons older than 60 years,[9] and assisted-living facilities reported a surge in applications after the storm.[10] However, not yet documented is the impact of the storm on older adults' psychological well-being. Some research indicates that older people facing disasters experience lower rates of psychopathology than do younger people,[11-13] whereas other studies have documented comparable[14,15] or increased rates.[13,16,17] Older adults are potentially vulnerable during disasters given the innate developmental challenges of aging. As individuals age they transition from the third old age of functioning well (ie, experiencing gains in abilities) to the fourth old age characterized by declines.[18] This shift, whereby loss outweighs gains, is a person-specific process and can happen at any time for older individuals (eg, age 60 or age 90) and aligns with increased biological and social vulnerability whereby older individuals are less likely to be able to maintain their same levels of functioning. The onset of a natural disaster during this phase of life may result in negative psychological outcomes for some but not others. Given the differential findings in the literature, more work is needed to understand characteristics that put older adults at risk for developing negative outcomes following a natural disaster.

PTSD in the Context of Aging and a Disaster

PTSD is a major public health concern that severely impacts the mental and physical well-being of those affected. Research has explored the prevalence of PTSD, the recovery trajectories of affected individuals, clinical treatments for PTSD, and the development of PTSD in the post-war context[19-22]

and man-made disasters.[23] Yet, the development and impact of PTSD in older adults exposed to natural disasters has received comparably little attention. Only recently have researchers begun to systematically examine disaster impacts on negative psychological outcomes for older people, with mixed results. Pietrzak and colleagues[24,25] examined the effects of Hurricane Ike and found 3 different trajectories of the development of PTSD for older persons (mean age: 69 years): resistant, chronic, and delayed-onset. Kun and colleagues[26] and Xu and Wu[27] found higher prevalence rates of PTSD for older people (aged 65 years and older; aged 51–68 years) and longer recovery trajectories when compared to younger age groups among those in highly damaged areas of the Wenchuan earthquake. Meanwhile, Kessler and colleagues[28] found that PTSD increased after Hurricane Katrina at higher rates for people aged 40 to 59 years than for people aged 60 and older or those aged 18 to 39 years. Xu and Song[29] found PTSD rates to be highest in young people after the Wenchuan earthquake, and Acierno and colleagues[11] studying the effects of the 2004 Florida hurricanes found that people aged 60 and older reported fewer PTSD symptoms than people aged 18 to 59 years. These discrepant findings underscore the need for further work regarding the factors that may predispose older people to PTSD following a natural disaster. Given the diversity of the aging population, it may be that some older adults are more vulnerable than others.

Factors Associated With the Development of PTSD in Older Adults After a Disaster

Risk factors for PTSD are typically categorized on the basis of their temporal relation to disaster[30]: pre-disaster variables are characteristics knowable before a disaster (eg, gender, age, ethnicity), peri-disaster variables are characteristics occurring during the disaster (eg, amount of exposure, immediate response, injury), and post-disaster variables are characteristics measured after a disaster that may foster or hinder recovery (eg, social support). Regarding pre-disaster characteristics, PTSD has been consistently linked to gender (eg, women),[4,26,27,29,31-33] lower income,[29,31,34] and marital status.[31,34] PTSD has also been linked to disability,[35] chronic health conditions,[36] prior trauma,[3-6] mental health comorbidities (eg, depression),[19,37,38] and health behaviors (eg, alcohol use).[39] Among peri-disaster variables, level of exposure has been confirmed as a perquisite to the development of PTSD.[7,25,29] Finally, post-disaster characteristics associated with PTSD include lack of emotional and social supports.[4,19,40,41]

Despite the wide array of work on the factors linked to PTSD, few studies have examined how pre- and peri-disaster characteristics increase the susceptibility of older people to developing PTSD. One common methodological limitation is that pre-, peri-, and post-disaster data are usually collected after a disaster strikes. For example, Kessler and colleagues[28] collected baseline data for their study of Hurricane Katrina 5 to 7 months after the hurricane, Acierno and colleagues[11] collected data for their study of the 2004 Florida hurricanes 8 to 10 months following the hurricanes, Pietrzak and colleagues[24] collected data 2 to 5 months after Hurricane Ike, and Xu and colleagues[27,29] collected data 12 to 17 months after the Wenchuan earthquake. Collection delays may inhibit reliable retrospective reporting or the ability to draw conclusions about causal relationships because all variables were measured at the same point in time. Phifer[42] began to address this issue by examining the differential vulnerability for developing PTSD in older adults exposed to severe flooding in Kentucky in 1984, utilizing a longitudinal pre-disaster and post-disaster design. He found that men, persons with lower occupational status, and those aged 55 to 64 years were more likely to develop negative psychological symptoms. Seplaki et al[43] similarly tested for effects on depressive symptoms with a pre-post design in individuals aged 54 to 70 years in Taiwan after the 1999 Chi-Chi earthquake. Meanwhile, Caramanica and colleagues[7] examined the impact of Sandy on PTSD for individuals in New York City who were also impacted by 9/11. However, replication and extension of this work is warranted.

Current Study

Our analyses add a substantial contribution regarding disaster effects on older adults owing to independent data collections both before and following the disaster. We were able to examine the extent to which a range of pre-disaster and peri-disaster characteristics influenced the development of PTSD among a sample of community-residing individuals aged 56 to 80 years. Using data drawn from a large representative panel of older adults in New Jersey, we explored characteristics that may predispose older adults to developing PTSD. We further differentiated our work by accounting for known effects of gender[26] and exposure[33] on PTSD by matching participants by use of innovative geospatial techniques and then examining group differences between people who developed PTSD and those who did not.

Our analyses addressed the question, *How do older individuals who experienced home damage from Hurricane Sandy and reported clinically significant levels of PTSD symptoms differ from those who lived in the same geographic areas, were the same gender, and reported the same level of home damage but did not develop PTSD symptoms?* We hypothesized that individuals who developed PTSD symptoms would report greater vulnerability years before the storm as evidenced by poorer physical health, functional ability, and mental health (eg, depression, negative affect). We also hypothesized that people developing PTSD symptoms would have experienced greater emotional distress during the storm.

METHODS

Data were derived from the ORANJ BOWL (Ongoing Research on Aging in New Jersey—Bettering Opportunities for Wellness in Life) research panel. ORANJ BOWL is a

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random-digit-dial sample of community-dwelling older adults in New Jersey who were first telephone-interviewed between November 2006 and April 2008 when they were aged 50 to 74 years ($N = 5688$).[44] At baseline, panelists had to be able to participate in a 1-hour English telephone interview; those who could not speak English or had cognitive or neurological impairments were excluded. Panelists were interviewed again 8 to 27 months after Hurricane Sandy hit the northeastern portion of the United States in October 2012 ($N = 3279$); they were then aged 56 to 80 years. Panelists reported on their demographic characteristics and physical and emotional health at baseline and their exposure and reactions to Hurricane Sandy after the hurricane. Panelists were compensated with a small gift after each wave of data collection. The authors' Institutional Review Board approved all data collection procedures.

Measures

Post-Traumatic Stress Symptoms

To assess symptoms of PTSD, the Posttraumatic Stress Disorder Symptom Scale—Self Report (PSS-SR) was utilized.[45] The PSS-SR is a valid and reliable measure of PTSD in older adults.[31] Participants responded to 17 items that captured the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM-IV), symptoms of PTSD rated from 0 (not at all or only one time) to 3 (5 or more times a week, almost always). Example items include: reliving Sandy; trying not to think, talk, or have feelings about Sandy; and feeling emotionally numb. The possible range was from 0 to 51 with a suggested clinical cutoff of 14 or above for PTSD.[46] Consistent with work by Coffey and colleagues,[47] participants were classified in the PTSD group if they scored 14 or above (range: 14 to 35; mean = 19.95, SD = 5.01; $\alpha = 0.94$), while participants with a score of 0 or 1 were in the non-PTSD group. Participants scoring between 2 and 13 were dropped from the analyses to examine clear group differences between those with and without PTSD.

Demographic Characteristics

Participants reported their age, education, race, gender, marital status, income, and work status at baseline. Education was coded as 1 (not a high school graduate) to 5 (masters, doctorate, or professional degree). Race was coded as 0 (non-Caucasian) or 1 (Caucasian). Gender was coded as 0 (male) or 1 (female). Marital status at baseline was coded as 1 (married) or 0 (not married). Income was coded from 1 (less than $30,000) to 3 (more than $80,000; see Table 1). Work status was coded as 0 (not working) or 1 (working part-time or full-time).

Pre-Disaster Characteristics

Participants also reported on a series of individual characteristics at baseline (2006–2008). Depressive symptoms were assessed by using the 10-item Center for Epidemiologic

TABLE 1

Between-Group Differences in Older Adults Who Did or Did Not Report Clinically Significant Levels of PTSD Symptoms After Hurricane Sandy ($N = 88$)

	Non-PTSD ($n = 44$), Mean (SD) or No. (%)	PTSD ($n = 44$), Mean (SD) or No. (%)	*t*-Test or Chi-Square Test
Demographic Characteristics			
Baseline age	59.26 (7.15)	60.39 (7.19)	$t(86) = -0.71$, $P = 0.477$
Baseline education	3.50 (1.11)	3.34 (1.22)	$t(86) = 0.64$, $P = 0.524$
Race (Caucasian = 1)	39 (89%)	34 (77%)	X^2 (1, 87) = 0.23, $P = 0.225$
Baseline income	2.53 (0.63)	2.09 (0.75)	$t(84) = 2.96$, $P = 0.004$
Baseline work status (working = 1)	32 (73%)	17 (39%)	X^2 (1, 88) = 10.36, $P = 0.001$
Baseline marital status (married = 1)	32 (73%)	26 (59%)	X^2 (1, 84) = 2.01, $P = 0.157$
Individual Pre-Storm Characteristics			
Depressive symptoms	3.39 (3.34)	8.75 (7.07)	$t(61.30) = -4.55$, $P < 0.001$
Mental health diagnosis (diagnosis = 1)	5 (11%)	18 (41%)	X^2 (1, 87) = 10.40, $P = 0.001$
Positive affect	15.57 (2.56)	13.45 (3.82)	$t(75.17) = 3.05$, $P = 0.003$
Negative affect	6.00 (2.48)	8.14 (3.73)	$t(74.73) = -3.16$, $P = 0.002$
Subjective health	4.84 (0.91)	3.93 (1.11)	$t(86) = 4.20$, $P < 0.001$
Functional ability	42.32 (4.99)	37.34 (7.69)	$t(73.74) = 3.60$, $P = 0.001$
Pain	1.73 (2.13)	4.16 (2.73)	$t(86) = -2.43$, $P < 0.001$
Social support	17.73 (2.23)	15.77 (3.81)	$t(69.40) = 2.93$, $P = 0.005$
Alcohol use	0.70 (0.63)	0.55 (0.66)	$t(86) = 1.15$, $P = 0.252$
Number of diagnosed conditions	1.68 (1.54)	3.27 (1.77)	$t(86) = -4.50$, $P < 0.001$
Reaction to Hurricane Sandy			
Feeling in physical danger	1.43 (0.55)	1.93 (0.70)	$t(86) = -3.75$, $P < 0.001$
Feeling distressed or fearful	1.61 (0.54)	2.43 (0.63)	$t(86) = -6.58$, $P < 0.001$

Abbreviation: PTSD, post-traumatic stress disorder.

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Studies Depression Scale (CES-D).[48] Participants rated how often they experienced 10 feelings (eg, depressed, that everything was an effort, lonely) in the past week by use of a scale of 0 (rarely or none of the time) to 3 (most or all of the time; $\alpha = 0.87$). Mental health diagnosis was measured by asking participants if they had ever been told by a doctor or other health professional that they had depression, anxiety, or other emotional problem, 0 (no) or 1 (yes). Positive and negative affect were each measured by using 5 questions scored on a Likert scale from 0 (never) to 4 (nearly always). Higher scores indicated more negative ($\alpha = 0.76$) or more positive affect ($\alpha = 0.73$).[49] Participants reported their subjective health on a scale from 1 (very poor) to 6 (excellent). Functional ability was measured by using 9 items that asked participants to rate their upper and lower body capabilities on a scale from 1 (you can't do it at all) to 5 (not at all difficult; $\alpha = 0.92$).[50] Pain was measured by using 3 questions (eg, How often are you troubled with pain?) rated from 0 (almost never) to 3 (almost always; $\alpha = 0.88$). Social support was measured by using 4 questions assessing access to listening support, advice, affection, and dependable support ($\alpha = 0.89$). Baseline level of alcohol use was coded from 0 (no alcohol consumption) to 2 (heavy drinker). A count of the number of diagnosed medical conditions was tabulated from responses to questions about whether 14 conditions had been diagnosed by a health care provider (arthritis, hypertension or high blood pressure, heart conditions, cancer, diabetes, osteopenia or osteoporosis, stroke, liver disease or hepatitis, lung or breathing problems, Parkinson's disease, multiple sclerosis, migraines, mental health, and HIV or AIDS; range, 0 to 8).

Peri-Disaster Characteristics

Respondents reported the extent to which Hurricane Sandy damaged their home and the extent to which they felt in physical danger and distressed or fearful during Hurricane Sandy, each rated as 1 (not at all), 2 (a little), or 3 (a lot).

Procedures

To examine group differences on pre- and peri-disaster characteristics, we identified individuals within the ORANJ BOWL sample who completed data collection at both time points, reported clinically significant levels of PTSD (PSS-SR scores of $\geq$ 14) following the storm, *and* reported experiencing either a little (moderate) or a lot (severe) of home damage during Hurricane Sandy ($n = 48$). Second, we identified a sample of ORANJ BOWL participants who had completed both waves of data collection and had reported a little or a lot of home damage but reported no PTSD ($n = 585$; PSS-SR scores of $\leq$1). Third, each participant reporting PTSD was matched to a participant without PTSD symptoms on the basis of (1) gender, (2) level of home damage reported (ie, a little or a lot), and (3) geographic proximity. We matched on these characteristics given known differences in mental health outcomes by gender (women typically report higher levels of PTSD[32]), exposure to the storm,[7,25,29,51] and socioeconomic status.[29,31,34] Matching participants on geographic location in addition to ratings of exposure helped to account for the different types of damage individuals may have experienced, aligning individuals inland that likely experienced wind or tree damage and aligning those on the coastline who likely experienced damage such as flooding. Preliminary work within the larger study sample demonstrated that higher ratings of subjective exposure were linked with greater occurrence of PTSD after accounting for demographic and baseline clinical characteristics of participants ($B = 0.35$, SE = 0.01, $P < 0.001$, $n = 2205$).[52]

The matched database was created by use of geospatial cohort analysis techniques.[53-56] Pairing was conducted in ArcGIS 10.3 by using the "Near" function, which matches individuals from a target set (exhibiting PTSD symptoms) with the closest individual from a set of potential matches (no PTSD symptoms). In cases where the same non-PTSD candidate was matched to more than one PTSD individual, the results were refined by using "generate near table" to identify 3 potential matches, and conflicts were manually resolved to minimize average distances between matched pairs. Four people with PTSD symptoms were dropped from the analyses because of invalid New Jersey state addresses ($n = 2$) or the inability to produce a valid, nonoverlapping geographic match ($n = 2$).

The final sample included 88 adults aged 56 to 80 years: 44 reporting clinically significant levels of PTSD and 44 matched cases reporting no PTSD. Matched pairs lived an average of 3.82 miles apart, with distances ranging from 0.19 to 18.20 miles. Nineteen pairs experienced "a lot" of damage (13 female pairs, 6 male pairs) and were on average 6.87 miles apart. Twenty-five pairs experienced "a little" damage (19 female pairs, 6 male pairs) and were on average 1.81 miles apart (Table 1). See Figure 1 for a geographic distribution of participants by gender, exposure, and PTSD symptom status.

Analyses

We conducted *t*-tests and chi-square difference tests to determine group differences by PTSD group status across all pre-disaster and peri-disaster characteristics. Bivariate correlations were run to determine the associations among variables. Highly interrelated variables ($r > 0.50$) were trimmed from the list of predictors (work status, positive and negative affect, mental health diagnosis, pain, subjective health, functional ability, and feeling distressed or fearful) in order to decrease interdependence (collinearity) and to narrow the variables tested with logistic regression (see Table 2). Exact logistic regression was used to test group prediction, which models a binary outcome variable when the sample size is too small for a standard logistic regression or when some of the cells formed by the outcome and categorical predictor variable have no observations. The estimates given by exact

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TABLE 2

Correlations Among Significant Individual Characteristics (*N* = 88)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Income	–	–	–	–	–	–	–	–	–	–	–	–	–
2. Work status	0.44[c]	–	–	–	–	–	–	–	–	–	–	–	–
3. Depressive symptoms	−0.35[c]	−0.38[b]	–	–	–	–	–	–	–	–	–	–	–
4. Mental health diagnosis	−0.19	−0.29[b]	0.61[c]	–	–	–	–	–	–	–	–	–	–
5. Positive affect	0.10	0.20	−0.64[c]	−0.45[c]	–	–	–	–	–	–	–	–	–
6. Negative affect	−0.14	−0.22[a]	0.71[c]	0.50[c]	−0.56[c]	–	–	–	–	–	–	–	–
7. Subjective health	0.28[b]	0.27[a]	−0.53[c]	0.38[c]	0.51[c]	−0.43[c]	–	–	–	–	–	–	–
8. Functional ability	0.35[b]	0.41[c]	−0.50[c]	−0.42[b]	0.28[b]	−0.27[a]	0.52[c]	–	–	–	–	–	–
9. Pain	−0.33[b]	−0.37[c]	0.49[c]	0.44[c]	−0.38[c]	0.38[c]	−0.52[c]	−0.71[c]	–	–	–	–	–
10. Social support	0.27[a]	0.26[a]	−0.37[c]	0.32[b]	0.36[b]	−0.40[c]	0.33[b]	0.14	−0.16	–	–	–	–
11. Number of diagnosed conditions	−0.25[a]	−0.47[c]	0.49[c]	0.53[c]	−0.23[a]	0.31[b]	−0.46[c]	0.56[c]	0.51[c]	−0.24[a]	–	–	–
12. Feel in physical danger	−0.22[a]	−0.08	0.19	0.13	−0.08	0.18	−0.14	−0.18	0.17	−0.12	0.16	–	–
13. Feeling distressed or fearful	−0.24[a]	−0.07	0.30[b]	0.03	−0.20	0.31[b]	−0.17	−0.21	0.30[b]	−0.15	0.26[a]	0.62[c]	–

Significance: [a]$P < 0.05$, [b]$P < 0.01$, [c]$P < 0.001$.

TABLE 3

Exact Logistic Regression Predicting Group Membership of PTSD Versus Non-PTSD (*N* = 88)

	Model 1					Model 2				
	Estimate	SE	Wald Chi-Square	Odds	95% CI	Estimate	SE	Wald Chi-Square	Odds	95% CI
Intercept	0.99	2.00	0.25	–	–	−4.18	2.89	2.10	–	–
Demographic Characteristics										
Baseline Income	−0.42	0.39	1.15	0.66	0.31–1.42	−0.20	0.50	0.15	0.82	0.31–2.19
Individual Pre-Storm Characteristics										
Depressive Symptoms	0.15[a]	0.07	4.06	1.16	1.00–1.34	0.11	0.08	1.98	1.12	0.96–1.32
Social Support	−0.11	0.10	1.28	0.90	0.74–1.08	−0.16	0.12	1.73	0.86	0.68–1.08
Number of chronic conditions	0.44[a]	0.18	5.94	1.55	1.09–2.20	0.61[b]	0.23	7.02	1.85	1.17–2.91
Reaction to Hurricane Sandy										
Feeling distressed or fearful	–	–	–	–	–	2.54[c]	0.67	14.22	12.67	3.39–47.39
Wald Chi-square (df)			17.55 (4)[b]					20.34 (5)[b]		
−2 Log Likelihood			119.22					119.22		
AIC			121.22					121.22		

Abbreviations: CI, confidence interval; PTSD, post-traumatic stress disorder; SE, standard error.
Significance: [a]$P < 0.05$, [b]$P < 0.01$, [c]$P < 0.001$.

logistic regression do not depend on asymptotic results. Analyses were performed by using SAS 9.3. A stepwise approach was taken in model building. Model 1 included the individual-level demographic and pre-disaster clinical characteristics: income, depressive symptoms, social support, and number of diagnosed conditions. Model 2 added the peri-disaster subjective reactions to Hurricane Sandy.

RESULTS

Tests of group differences revealed that after older adults were matched by gender, amount of home damage, and geographic proximity, those who developed PTSD symptoms after Hurricane Sandy reported lower income, were less likely to be working, reported more depressive symptoms, and were more likely to have a mental health diagnosis before the storm. People developing PTSD symptoms had lower positive affect, higher negative affect, poorer subjective health, lower functional ability, greater pain, lower social support, and more diagnosed chronic medical conditions years before Hurricane Sandy compared with those who did not develop PTSD. Additionally, individuals who developed PTSD symptoms reported higher rates of feeling in physical danger and distress or fear during the storm than did people who did not develop PTSD. There were no significant differences in age, education, race, marital status, or alcohol use between the 2 groups (Table 1).

Model 1 of the exact logistic regression analyses was significant (Wald $\chi^2 = 17.55$, $P = 0.002$) and revealed significant unique predictive associations of depressive symptoms and number of chronic health conditions with PTSD group membership (Table 3, Model 1). For every 1-unit change in depressive symptoms, the expected log odds of PTSD increased by 1.16. For every 1-unit change in the number of chronic health conditions, the log odds of PTSD increased by 1.55. Adding subjective exposure to model 2, the overall model (Wald $\chi^2 = 20.34$,

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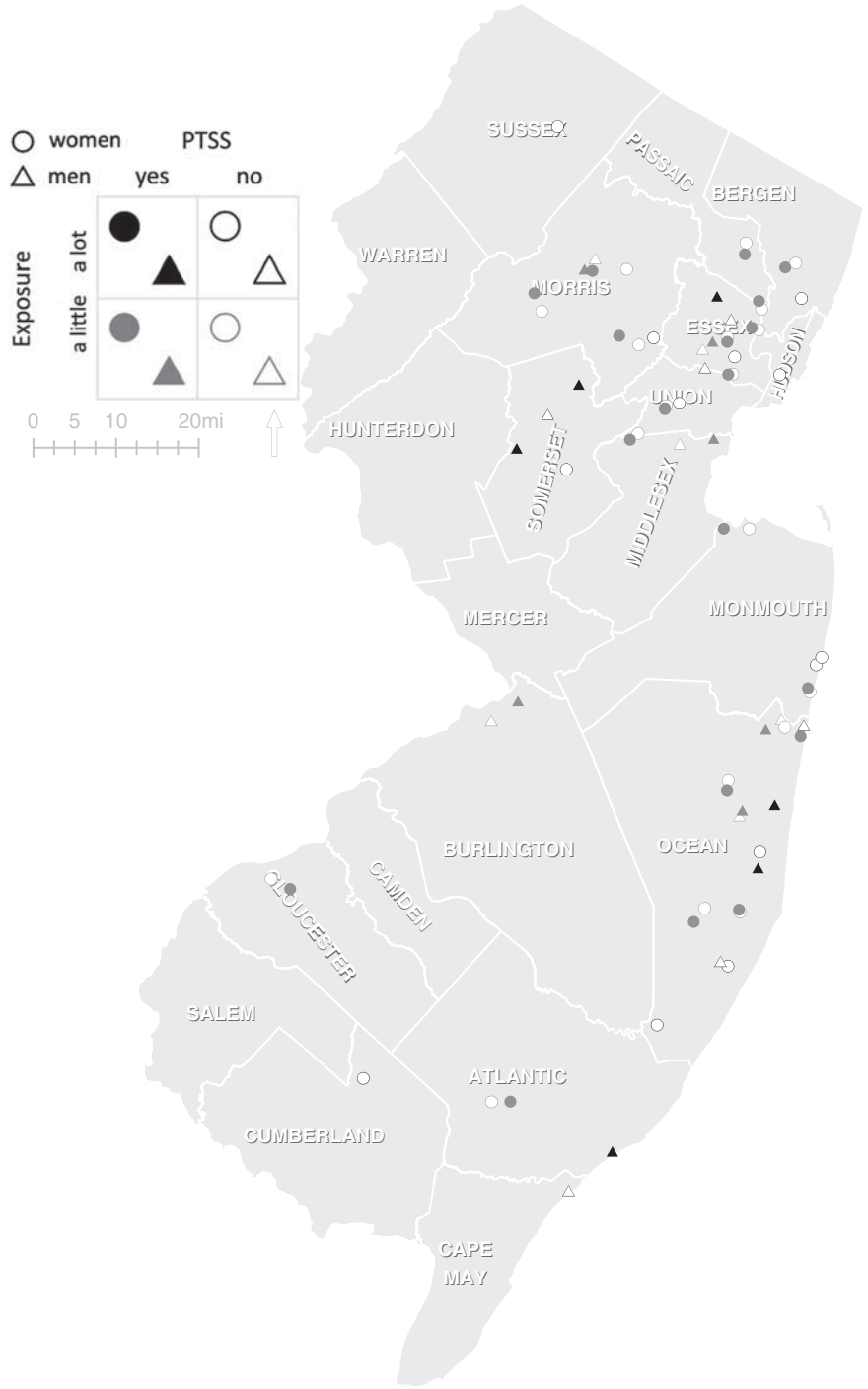
FIGURE 1

Map of New Jersey Depicting Selected PTSD and Non-PTSD Cases by Gender and Level of Damage



Abbreviations: PTSD, post-traumatic stress disorder; PTSS, post-traumatic stress symptoms.

$P = 0.001$) and the association with chronic health conditions remained significant; however, depressive symptoms lost significance and distress became significant. For every 1-unit change in reports of distress, the log odds of PTSD increased by 12.67 (Table 3, model 2).

DISCUSSION

The results indicated that years before Hurricane Sandy hit, there were clear differences in older adults who would develop PTSD symptoms after the disaster and those who would not. After accounting for gender and storm exposure,

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older adults who were more vulnerable in regard to health status and social supports before the storm were more likely to develop clinically significant levels of PTSD. These results confirm findings from prior studies that rely on post-disaster and retrospective evaluations and expand our understanding of PTSD vulnerability characteristics for older persons.[11,24,28]

In regard to functional abilities and health, our findings are consistent with other work suggesting that older adults who experience reduced ability, or resilience, are more vulnerable in the face of a natural disaster.[19,35,36] The cumulative impact of illnesses, disability, and stressors seems to reduce the ability of older individuals to cope with a severe trauma or to stretch coping resources thin. This may be true when the older person experiences more pain, more chronic diseases, lower functional ability, and lower subjective health as found in the group differences reported here. Such a speculation regarding resources is supported by the differences in income and work status[31,43]; those who developed PTSD symptoms had fewer resources before the storm.

Regarding mental health, the experience of prior depressive symptoms and having a diagnosis of depression reflects a diminished ability to cope with a disaster. Psychological vulnerability before a storm increases susceptibility for PTSD.[19,37,38] Our results expand prior findings by including positive and negative affect. People who developed PTSD symptoms not only reported higher ratings of clinical indicators of mental health vulnerability (eg, depression, mental health diagnosis), but also reported less positive affect and higher levels of negative affect years before the storm. This finding may indicate an overall mental health capacity or a personality predisposition that is linked to PTSD development. Or, this finding may reflect individuals' prior engagement of coping responses within their lives, whereby those experiencing greater levels of positive affect and lower negative affect are adapting better overall. Ultimately, the results highlight the variety of physical and mental health characteristics by which we can identify older adults most vulnerable to the negative impacts of a disaster. Knowledge of pre-disaster characteristics may help communities or the disaster preparedness workforce determine where resources are most needed to help older adults cope most effectively. Pointed efforts that use door-to-door community outreach efforts or collaborate with Area Agency on Aging offices in the community may help the responder community identify those most in need.

Our results regarding subjective exposure of negative emotions are consistent with clinical guidelines and other work. DSM-IV criteria indicate that a person develops PTSD if he or she reports fear, helplessness, or horror.[19] The greater reports of fear during the storm, as found in these analyses, are consistent with this clinical demarcation of PTSD and prior work using post-disaster cross-sectional designs.[29] However, the unique predictive power of "feeling distressed" in the logistic regression models may further indicate that it is the person's subjective emotional response that matters most. Yet, we also see that depression is predictive of PTSD group membership *before* we account for the emotional distress felt during the storm. The report of emotional distress during the storm may represent underpinning mental health vulnerability. Being aware of a person's pre-storm experience with depression may help to identify individuals more susceptible to experiencing distress and later PTSD. Expansion of programs such as New Jersey Hope and Healing (http://www.mhanj.org/new-jersey-hope-and-healing/) that draw upon community mental health organizations to reach out to individuals affected by disasters may be able to target older persons, particularly those with a history of emotional problems. Such efforts can work to keep older adults calm and to help them cognitively process a negative event through tailored communication techniques, which may in turn reduce psychological distress and PTSD.

Findings regarding social support are particularly important in informing preparedness efforts and are consistent with prior work.[7,41] Individuals developing PTSD symptoms in this New Jersey sample of older adults after Hurricane Sandy reported lower levels of social supports before the storm compared with those who did not develop PTSD. This finding indicates that older persons disconnected from social supports are more vulnerable to negative outcomes. These results extend prior work by showing that it may be a history of disconnection from social support (4 to 6 years before the storm) that increases vulnerability. Efforts that seek to increase social supports among older persons and their neighbors, relatives, or peers may diminish the negative psychological outcomes of a disaster, because more support has also been linked to greater preparedness.[57] This speaks to a need for a public health focus on continual community building to bolster support-seeking opportunities and maximize psychological adjustment for those exposed to a disaster.[58]

Limitations

Although this study had many strengths, like all studies, it had limitations. The empirical approach taken focused on group differences; more could be learned from studying person-specific trajectories over time. Second, we did not have information about the individuals' history of PTSD or trauma exposure prior to Hurricane Sandy, which may influence the development of subsequent PTSD or lead to the continuation of symptoms over time.[3,5-7,19] Third, the range of time between Hurricane Sandy and our post-hurricane assessment (from 8 to 27 months) could yield qualitatively different clinical experiences depending on when the assessment was completed.[19] We were unable to decipher the clinical progression of PTSD in these older adults or know whether any of these individuals received psychological treatment after the storm. Research designs that enable assessments more proximate to a natural disaster and those that include additional assessments in the months following a

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disaster would enable greater understanding of how PTSD develops and progresses over time. Fourth, other factors not examined here may be more salient in distinguishing older adults who develop PTSD from those who do not following a natural disaster (ie, event centrality, personal control, or genetic make-up).[59,60] In addition, only older adults were included in the study sample, which precludes assessment of the differential impact of the hurricane on older versus younger age groups in the affected population. Comparing the findings of this older age group with younger groups, or including older individuals with cognitive vulnerabilities, in future work would further our understanding of the impacts of disasters on older individuals. We also note that peri-disaster experiences and PTSD were assessed at the same time and caution against attributing causality between these variables. Finally, despite the use of statistical methods appropriate for small sample sizes (ie, exact logistic regression), the reliability of the results presented here are limited owing to the small sample size available. Further, generalizability is limited to older individuals living in New Jersey who reported home damage due to Hurricane Sandy. Replication is needed in a larger, more diverse sample of individuals exposed to other hurricanes and other types of disaster to validate these findings.

CONCLUSIONS

Overall, this investigation took an innovative approach to examining differences in characteristics of older adults developing versus not developing symptoms of PTSD. Our findings showed that not all older adults develop PTSD when exposed to a natural disaster, such as Hurricane Sandy, but those who do develop clinically significant levels of PTSD symptoms report lower levels of physical and psychological well-being and diminished social supports years before a storm. Our findings identify characteristics of older persons likely to be at risk. There is a need to develop disaster preparedness techniques that identify targeted individuals who may suffer most from a disaster. In addition, systematic efforts are needed to implement strategies that bolster vulnerable older adults' resilience during an event. Pointed attention to the needs and limitations of vulnerable older adults can lead to reductions in negative psychological outcomes following a disaster.

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